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VOL. CXXXVII.—No. 3565] LONDON: FRIDAY EVENING, APRIL 25, 1924 [PRICE ONE SHILLING BY INLAND POST 1s. 2d.

The Engineer

PRINCIPAL CONTENTS OF THIS ISSUE.

The British Empire Exhibition (First Notice).
The Water Power Resources of Canada.
The Design of Works in Open Channels.
Camden Town Tube Extension.
An Experimental River.
Institution of Naval Architects—No. III.
Sliding Cylinder Marine Oil Engine.
A Large Crank Axle Lathe.
Communication Circuits.

PUBLIC NOTICES

The Director-General, India Store Department, Branch No. 13, Belvedere-road, Lambeth, S.E., REQUIRES :—
1. CORRUGATED M.S. SHEETS, GALVANISED.
2. WHEELS AND AXLES, C and W Disc Type.
Tenders due on the 6th May, 1924. Tender forms obtainable from above. 5579

G. R.

BY DIRECTION OF THE SURPLUS STORES, &c., LIQUIDATION DEPARTMENT, TREASURY.

The Department would Draw THE ATTENTION OF MANUFACTURERS, ENGINEERS AND ALL OTHERS SEEKING FACTORY PREMISES, to the fact that they have for disposal FACTORY PREMISES in certain INDUSTRIAL AREAS OF ENGLAND AND SCOTLAND suitable for the establishment of ENGINEERING WORKS, CHEMICAL WORKS, WORKS OR MILLS REQUIRING A PLENTIFUL WATER SUPPLY, and WORKS FOR LIGHT OR HEAVY MANUFACTURE.
The floor space varies from 4,000 square feet to 500,000 square feet, and most of the Factories have RAILWAY FACILITIES and some have CANAL and RIVER FRONTAGES.
Also FREEHOLD FACTORY SITES FOR SALE with areas varying from 5 to 200 ACRES.
Will applicants state their specific requirements and apply for full particulars to The Chief Valuer, Surplus Stores, &c., Liquidation Department, Treasury, Room 286, Caxton House, Tothill Street, London, S.W.1. 5494

Borough of Colchester.
The Corporation invite TENDERS for SUPPLY, DELIVERY and SETTING TO WORK of the following PLANT and EQUIPMENT at their proposed new Power Station at the Hythe, Colchester.
Section 1.—20-Ton ELECTRIC TRAVELLING CRANE.
Section 2.—DRY-BACK BOILERS (10,000 lb. steam per hour) and SUPERHEATERS.
Section 3.—WATER-TUBE BOILERS (10,000 lb. and 20,000 lb. steam per hour) and Integral Superheaters and Economisers.
Section 4.—COAL CONVEYING and HANDLING PLANT, WAGON TIPPLER and WEIGHBRIDGE.
Section 5.—STEEL CHIMNEY and INDUCED DRAUGHT MOTOR FANS.
Section 6.—TURBO-ALTERNATORS (1250 KW., 1500 K.V.A.) and SURFACE CONDENSING PLANT, PUMPS, &c.
Section 7.—ROTARY CONVERTERS (1000 KW. and 250 KW.) and TRANSFORMERS.
Section 8.—E.H.T., L.T. and A.C. SWITCHGEAR, D.C. SWITCHGEAR and CABLE CONNECTIONS.
Section 9.—NOZZLES, VALVES and PIPES for COOLING POND, MOTOR PUMPS for RESERVOIR, &c.
Section 10.—E.H.T. FEEDER and PILOT CABLES, L.T. CABLES and ROADWORK.
Section 11.—TRANSFORMERS and EQUIPMENT for SUB-STATIONS.
Persons desiring to tender must communicate their intention to Mr. W. C. C. Hawtayne, of 9, Queen-street-place, London, E.C. 4, the Consulting Engineer for the scheme, on or before Saturday, the 3rd of May, stating clearly the section or sections for which they desire to tender.
Specifications and plans will be issued on or about the 15th May to persons who have complied with the above requirement, and who, after receiving notice from the Consulting Engineer, send to the undersigned a deposit of Two Pounds in Treasury Notes for each section required.
The deposits will be returned on receipt of a bona fide Tender on or before the prescribed date.
Tenders, sealed and endorsed "Electricity Supply, New Generating Station," to be delivered to the undersigned on or before Twelve o'clock Noon on Monday, 2nd June, 1924.
The Corporation do not bind themselves to accept the lowest or any Tender.
H. C. WANKLYN, Town Clerk.
Town Hall, Colchester, April 17th, 1924. 5567

County Borough of SOUTHAMPTON.
COAL-HANDLING PLANT, BUNKER EXTENSIONS, &c.
The Corporation invite TENDERS for the MANUFACTURE, DELIVERY, ERECTION, &c., at their Electricity Works' Western Esplanade, Southampton, of ONE ROTARY WAGON TIPPLER, ONE COAL RECEIVING HOPPER, ONE GRAVITY BUCKET CONVEYOR, ONE SET of OVERHEAD COAL BUNKERS, forming an extension to the existing Bunkers, together with COAL CHUTES, &c.
A specification may be obtained of the Borough Electrical Engineer at the above-mentioned works, upon production of the Borough Treasurer's receipt for a deposit of £1 1s.
Deposits will be returned after the Council have dealt with the Tenders to contractors who have submitted bona fide Tenders.
Additional copies of the specification may be obtained upon payment of 10s. 6d. each, which is not returnable.
Sealed Tenders, endorsed "Coal-handling Plant, &c.," must be delivered at the Town Clerk's office by Twelve o'clock at Noon on Monday, 26th May, 1924.
No pledge is given to accept the lowest or any Tender.
R. R. LINTHORNE, Town Clerk.
23rd April, 1924. 5580

PUBLIC NOTICES

Metropolitan Water Board.
SUPPLY OF LATHES, &c., FOR BOARD'S TESTING SHOPS, ROSOMAN-STREET, CLERKENWELL, E.C. 1.
The Metropolitan Water Board invite TENDERS for the SUPPLY of LATHES, and other MACHINE TOOLS, for their Testing Shop, Rosoman-street, Clerkenwell, E.C. 1.
Forms of Tender and specification giving full particulars may be obtained from the Chief Engineer, Metropolitan Water Board, New River Head, 173, Rosebery-avenue, E.C. 1., by personal application (Room 155), or upon forwarding a stamped addressed brief envelope.
Tenders must be on the official forms, enclosed in sealed envelopes, and addressed to "The Clerk of the Board, Metropolitan Water Board, New River Head, 173, Rosebery-avenue, E.C. 1," endorsed "Tender for Lathes, &c.," and delivered at the offices of the Board not later than 11 a.m. on Wednesday, 30th April, 1924.
The Board do not bind themselves to accept the lowest or any Tender.
G. F. STRINGER, Clerk of the Board.
Offices of the Board, New River Head, 173, Rosebery-avenue, E.C. 1, 12th April, 1924. 5524

Metropolitan Water Board.
SUPPLY AND ERECTION OF FENCING, SHOOTERS HILL PUMPING STATION, KENT.
The Metropolitan Water Board invite TENDERS for the SUPPLY and ERECTION of approximately 1000 YARDS WROUGHT IRON FENCING at their Shooters Hill Works in the Kent District.
Forms of Tender, specifications, and drawings giving full particulars may be obtained from the Chief Engineer, Metropolitan Water Board, New River Head, 173, Rosebery-avenue, E.C. 1, by personal application (Room 155), or upon forwarding a stamped addressed brief envelope.
Tenders must be on the official forms, enclosed in sealed envelopes and addressed to "The Clerk of the Board, Metropolitan Water Board, New River Head, 173, Rosebery-avenue, E.C. 1," endorsed "Tender for Fencing, Shooters Hill," and delivered at the offices of the Board not later than 11 a.m. on Tuesday, 29th April, 1924.
The Board do not bind themselves to accept the lowest or any Tender.
G. F. STRINGER, Clerk of the Board.
Offices of the Board, New River Head, 173, Rosebery-avenue, E.C. 1, 12th April, 1924. 5525

The Bengal and North-Western RAILWAY COMPANY, LIMITED.
The Directors are prepared to receive TENDERS for the SUPPLY of :—
1000 TYRES for CARRIAGES and WAGONS, as per specification to be seen at the Company's offices.
Tenders, addressed to the undersigned, and marked "Tender for C. and W. Tyres," or as the case may be, with name of firm tendering, to be lodged not later than Noon on Tuesday, the 6th day of May, 1924.
For each specification a fee of 10s. will be charged, which cannot under any circumstances be returned.
The Directors do not bind themselves to accept the lowest or any Tender.
By Order of the Board, E. A. NEVILLE, Managing Director.
237, Gresham House, Old Broad-street, London, E.C. 2. 17/4/1924. 5572

PUBLIC NOTICES

Bombay, Baroda, and Central INDIA RAILWAY COMPANY.
The Directors are prepared to receive up to Noon on Friday, 9th May, TENDERS for the SUPPLY of :—STEEL MATERIAL (ANGLES, FLATS, PLATES, &c.).
Tenders must be made on forms, copies of which, with specification, can be obtained at these offices on payment of 20s. each (which will not be returned).
The Directors do not bind themselves to accept the lowest or any Tender.
S. G. S. YOUNG, Secretary.
Offices : 91, Petty France, Westminster, S.W. 1, 23rd April, 1924. 5563

The Great Indian Peninsula RAILWAY COMPANY, 48, Copthall-avenue, London, E.C. 2, invite TENDERS for :—

	Fee.
1. VERTICAL BOILERS	10s.
2. STEEL WORK FOR BRIDGES	7s. 6d.
3. POINTS AND CROSSINGS, &c.	10s.
4. MANTLES FOR LAMPS	2s. 6d.
5. STEEL DRAWBARS FOR WAGONS	2s. 6d.
6. LINOLEUM	5s.
7. EXPANDED METAL	2s. 6d.
8. CLOTH, &c.	2s. 6d.
9. MILD STEEL BARS	2s. 6d.

Tenders are due by 11 a.m. on 6th May, 1924. Tender forms obtainable at above address. Fees not returnable. 5582

The South Indian Railway COMPANY, Limited, are prepared to receive TENDERS for the SUPPLY of :—
1. ROOF WORK.
2. SPARE PARTS OF CARRIAGES AND WAGONS.
Specifications and forms of Tender will be available at the Company's Offices, 91, Petty France, Westminster, S.W. 1.
Tenders, addressed to the Chairman and Directors of the South Indian Railway Company, Limited, marked "Tender for Roof Work," or as the case may be, must be left with the undersigned not later than Twelve Noon on Friday, the 9th May, 1924.
The Directors do not bind themselves to accept the lowest or any Tender.
A charge, which will not be returned, will be made of 10s. for each copy of each specification.
Copies of the drawings may be obtained at the offices of Messrs. Robert White and Partners, Consulting Engineers to the Company, 3, Victoria-street, Westminster, S.W. 1.
A. MUIRHEAD, Managing Director.
23rd April, 1924. 91, Petty France, S.W. 1. 5595

County Borough of Warrington. WATERWORKS DEPARTMENT. ASSISTANT ENGINEER.
The Corporation of Warrington invite APPLICATIONS from persons who have been trained in a Waterworks Undertaking for the POSITION of an ASSISTANT ENGINEER.
Applicants with mechanical knowledge preferred.
The person to be appointed must not exceed 30 years of age and will have to devote the whole of his time to the duties of his office.
Salary £280 per annum, increasing £13 per annum to a maximum of £350 per annum.
Applications, stating age and particulars of the candidate's career, with copies of three testimonials, must be delivered to the undersigned at his office on or above the 10th May, 1924.
Canvassing is strictly prohibited.
A. T. HALLAWAY, Town Clerk.
Town Hall, Warrington, 14th April, 1924 5544

PUBLIC NOTICES

City of Liverpool.
STRUCTURAL DRAUGHTSMAN FOR CITY BUILDING SURVEYOR'S DEPARTMENT.
The Health Committee of the Corporation of Liverpool invite APPLICATIONS for the POST of a STRUCTURAL DRAUGHTSMAN in the City Building Surveyor's Office. The duties will comprise the examination and checking of structural steel work details and calculations, and candidates must have had good technical and shop training and drawing-office experience.
Salary will be at the rate of £215 per annum, rising by annual increments of £15 to £260 per annum.
The person appointed will be required to contribute to the Corporation Superannuation Fund. Applications, stating age (which must not exceed 35 years), experience and qualifications, together with copies of not more than three testimonials, are to be sent to the Town Clerk, Municipal Buildings, Dale-street, Liverpool, on or before the 10th May, 1924, endorsed "Structural Draughtsman."
Canvassing of the members of the Council will be regarded as a disqualification.
WALTER MOON, Town Clerk.
Town Clerk's Office, Liverpool, 23rd May, 1924. 5591

SITUATIONS OPEN

ASSISTANT ENGINEER REQUIRED to Take Charge of Carriage and Wagon Section of C.M.E.'s drawing-office on railway in South America. Age 27 to 35. Should be good Draughtsman, with practical Shops Experience on Railway Carriage and Wagon Building, mechanical and technical training, with at least two years in drawing-office on Railway Carriage and Wagon Design.—Apply by letter, giving full particulars, to FOX and MAYO, Consulting Engineers, 155, Dashwood House, E.C. 2. 5577 A

CAPABLE ENGINEER and LIVE MAN REQUIRED to Supervise the Progress of Work through Shops of General Engineering Works; man accustomed to accurate production and used to steam preferred. State age and experience; also wages required.—Address, 5556, The Engineer Office. 5556 A

ENGINEER REQD., London, with Exp. Buring Machinery for Export. Public school education, aged 28/33. £500 p.a.—Apply, LAURIE'S, Employment Specialists, 23, Basinghall-street, E.C. 2. No preliminary fee. 5536 A

ESTIMATING ENGINEER WANTED by Well-known Glasgow firm, one accustomed to the Preparation of Price Lists and Technical Information needed by foreign agents. Knowledge of Condensing Plant and Pump Work preferred. State age, wage, experience and when at liberty.—Address, 5564, The Engineer Office. 5564 A

REINFORCED CONCRETE DESIGNERS (TWO) WANTED. Send short summary of experience, qualifications, age and salary required. Only men with a specialist training and a general experience in the Design of Reinforced Concrete Work should apply.—Write, Box 653, T. B. Browne's Advertising Offices, 163, Queen Victoria-street, E.C. 4. 5575 A

WORKS MANAGER WANTED for Heavy Engineering Works in the Midlands. Age between thirty and forty.—Address, stating qualifications and salary, F3063, The Engineer Office. F3063 A

WORKS MANAGER WANTED by a Firm Employing 2000 hands, engaged in the manufacture of Chassis and Body Work for Motor Vehicles. It is absolutely essential that applicants should have first-class experience in Modern Machining Methods leading to a high standard of accuracy in repetition work, and be possessed of marked ability in shop organisation and control. The position offers a unique opportunity for an energetic "seven-thirty works" man, accustomed to controlling men and wrestling with difficulties and to quickly see some results from his efforts.—Write in the first instance, giving full particulars of experience, age, salary required, &c., to 5574, The Engineer Office. 5574 A

YOUNG MECHANICAL ENGINEER, Good Technical education, some shop experience. VACANCY in Flour-milling Engineering Department of Manufacturing and Consulting Engineers. Previous experience flour milling not necessary.—Address, 5562 The Engineer Office. 5562 A

WANTED by Firm of Industrial Engineers, ONE or TWO Smart JUNIOR DRAUGHTSMEN, accustomed to prepare 1/8th scale drawings for factories under supervision.—Write, stating age, experience and salary required and enclosing specimen of draughtsmanship, 5559, The Engineer Office. 5559 A

DRAUGHTSMAN, Fully Qualified, REQUIRED by Harbour Authority, temporarily, with experience in Design of Heavy Swing Bridges.—Write, with full particulars as to age, education, training, qualifications, experience and salary required, Box F 996, Lee and Nightingale, Advt. Offices, Liverpool. 5561 A

SITUATIONS OPEN (continued) Page 2.

SITUATIONS WANTED, Page 2.
PATENTS, Page 2.
PARTNERSHIPS, Page 2.
MACHINERY, &c., WANTED Page 2.
FOR SALE, Pages 2, 3, 4 and 96.
AUCTIONS, Pages 2 and 96.
PREMISES TO LET OR WANTED Page 2.
WORK WANTED, Page 4.
AGENCIES, Page 2.
MISCELLANEOUS, Page 2.

For Advertisement Rates see Page 447, Col 1.

NUMERICAL INDEX TO ADVERTISEMENTS Page 95.

SITUATIONS OPEN (continued)

DRAUGHTSMAN REQUIRED, with Good General Engineering Experience; must be capable of Handling Experimental Work. London district. State age, experience and salary required.—Address, 5565, The Engineer Office. 5565 A

DRAUGHTSMAN, Tramway and Railway Rolling Stock.—Apply (letter only), stating age, experience, and salary, to the CAR MANAGER, The English Electric Co., Ltd., Box 36, Preston, Lancs. 5519 A

DRAUGHTSMAN WANTED. Only Those with large experience in Colliery Winding, Haulage and other Mining Machinery need apply. State age, experience and wages required.—Address, 5563, The Engineer Office. 5563 A

MANCHESTER FIRM of Mechanical Engineers have a VACANCY for a capable and experienced DRAUGHTSMAN. Applicants should state fully age, training, record, and wages required.—Address, 5592, The Engineer Office. 5592 A

MACHINE SHOP FOREMAN REQUIRED to Take Complete Charge of the Repetition Machining of Steel Castings. Must be competent to devise set-ups for rapid production, and must be experienced rate-fixer.—Address, giving details of experience, copy references, and salary required, 5575, The Engineer Office. 5575 A

SITUATIONS WANTED

CERTIFICATED CHIEF ENGINEER, A.M.I.A.E., DESIRES POSITION as Manager, Works Engineer, or Control of Fleet; excellent references.—Address, P9000, The Engineer Office. P9000 B

COST REDUCTION Depends in the First Degree upon the supply of materials at a reasonable market figure, with security for delivery in unison with the rate of consumption. PURCHASING MANAGER, knowing all markets, exceptionally wide and matured organising and administrative experience, OFFERS his SERVICES.—Address, P8995, The Engineer Office. P8995 B

ENGINEER, A.M.I.M.E., with Practical Experience in erection and maintenance of hand and elec. cranes, telphers, lifts, conveyors, colliery equipment, structural steel work, pumping plant, boilers, steam and gas engines, will shortly be disengaged. With present employers 6 years, as erection superintendent and inspecting engineer; DESIRES POST. Good organiser and disciplinarian. Highest references.—Address, P9004, The Engineer Office. P9004 B

ENGINEER, M.I. Mech. E., 15 Years' Successful commercial experience with leading boilermaker, DESIRES a CHANGE. Specialist in steam plant equipment; design, superintendence and sales; highest credentials.—Address, P9001, The Engineer Office. P9001 B

ENGINEER (22) Yrs.) SEEKS OPENING in Drawing-office of Mechanical Engineer; 5 Yrs. shops, general engineering, and good technical education; will accept small salary.—G. LAMB, 2, Markham-square, Chelsea, S.W. 3. P9098 B

ENGINEER (27) SEEKS POSITION; 3 Years shops, 4 years engineering college (mechanical and civil engineering); 2 months D.O. experience; not afraid of hard work.—Address, P9096, The Engineer Office. P9096 B

ENGINEER (23), 5 Years Shops, 5 Years Sea, Experienced large semi-Diesel and petrol engines, WANTS POSITION trust ashore, home or abroad. French spoken.—85, Cowleston-street, Cardiff. P9097 B

ENGINEERING HARDWARE REPRESENTATIVE, just arrived from India, where he was for eighteen years travelling for hardware lines, is OPEN to ENGAGEMENT at British Empire Exhibition for interviewing purposes.—Box 19, Smith's Library, George-street, Richmond, Surrey. 5568 B

EXPERIENCED PRIME COST or LEDGER CLERK SEEKS PERMANENT POST with Engineering Firm, South of England preferred.—Write, C. C. C., c.o. Lamb and Colburn, 107, Wardour-street, Foreham, Hants. 5576 B

FOUNDRY MANAGER, at LIBERTY MAY 1st. Specialises in vertical pipe founding, flange, hyd. and S. and S. pipes. Can introduce special lines. First-class connection leading engineering firms.—Address, P9002, The Engineer Office. P9002 B

GENERAL Commercial Outside-erecting and Practical Engineering.—GENTLEMAN (30, ex-Lieut. of Artillery), public school, pupil and highly educated, DESIRES SUITABLE APPOINTMENT (possibly progressive). Particulars and interview obtainable London now.—Address, P9087, The Engineer Office. P9087 B

MECHANICAL ENGINEER, with Experience as manager of general engineering works and boiler works, used to control of office, estimating, interviewing, designing, maintenance and repairs, is DESIROUS OF OBTAINING SIMILAR ENGAGEMENT.—Apply, Box 753, Robertson and Scott, Edinburgh. 5580 B

MECHANICAL ENGINEER, with Good Record (general engineering) as foreman, cost clerk and manager, SEEKS responsible POST in works or office. Excellent references.—Address, P9007, The Engineer Office. P9007 B

POSITION WANTED as FOUNDRY FOREMAN-MANAGER; excellent ability, experience, character, &c.; age 49.—Address, P9004, The Engineer Office. P9004 B

SALES.—ADVERTISER (27), with Sales Training, who is at present on works staff, DESIRES CHANGE to SALES SIDE. Public school, college (engr.), ex-Service. Write for particulars.—Address P9088 B, The Engineer Office. P9088 B

WATER POWER ENGINEER and WATER TURBINE DESIGNER shortly REQUIRES ENGAGEMENT; 20 years' experience; A.M.I.M.E.—Address, P8972, The Engineer Office. P8972 B

YOUNG MAN (23), G.I. Mech. E. (Passed A.M.I. Mech. E. exam.), 5 years shops and drawing-office, REQUIRES APPOINTMENT with prospects.—Address, P9074, The Engineer Office. P9074 B

CHIEF DRAUGHTSMAN DESIROUS REPRESENTATION Midland area engineers, making boilers, accessories, all kinds pressure and constructional steel work.—Address, P9006, The Engineer Office. P9006 B

DRAUGHTSMAN (29), Mechanical Electrical, DESIRES CHANGE. Experience in workshop, erection, and running of central station plant; 4 years D.O., lay-out and details of modern central station and factory plant, pipe work, and general engineering.—Address, P9099, The Engineer Office. P9099 B

ENGINEER DRAUGHTSMAN, Age 27, DESIRES APPOINTMENT, General mechanical and constructional experience; 10 years as manufactory of well-known London firm. Technical or commercial post required.—Address, P9005, The Engineer Office. P9005 B

ENGINEER WANTS EMPLOYMENT as Draughtsman or on Executive Staff. Sound experience in furnaces, drying stoves and foundry plant, steel castings and weldless tubes, general and hydraulic machinery and works lay-out, works management.—Address, P9008, The Engineer Office. P9008 B

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AGENT, with Offices at Newport, Mon., Good S. Wales connection, would LIKE a few additional AGENCIES for Engineering Material, &c.—Address, P8996, The Engineer Office. P8996 D

A.M.I.C.E., with Good Office in Kingsway (Telephone and typist), SEEKS ONE or MORE AGENCIES in order to represent good provincial firms in London.—Address, P9001, The Engineer Office. P9001 D

RAILWAY AND DOCK ENGINEERS

ARE REQUESTED to SEND ENQUIRIES for all RAILWAY MATERIALS and ROLLING STOCK, any quantity, for all gauges, to—

"EXPORT DEPT.,"

R. H. NEAL and CO.,

Plant House,

EALING, LONDON, W. 5. 5368 D

CIVIL ENGINEER, Offices in Westminster First-class connection with engineering contractors, DESIRES AGENCIES for Plant and Engineering Tools. Unexceptional references can be given.—Address, 5596, The Engineer Office. 5596 D

EXPERIENCED and Educated ENGINEER, Opening office in Cardiff, DESIRES REPRESENTATION of one or two large FIRMS. Energetic, ambitious, able to tackle any job and see it through. Only first-class firms considered.—Address, P9003, The Engineer Office. P9003 D

GLASGOW FIRM of ENGINEERS and MERCHANTS, with a capable technical staff and having a firmly established connection with the Shipbuilders, Engineers and Founders throughout Scotland, could successfully undertake the REPRESENTATION of an additional first-class firm manufacturing for these trades.—Address, P8993, The Engineer Office. P8993 D

REQUIRED, 3 REPRESENTATIVES, to Sell a special make of Belting on a commission basis. State ground covered.—Address P8999, The Engineer Office. P8999 D

PATENTS

THE PROPRIETOR of BRITISH PATENT No. 148,864, dated April 1st, 1914, relating to "Driving Mechanism for Printing Presses," is DESIROUS of ENTERING into ARRANGEMENTS by WAY of a LICENCE or otherwise on reasonable terms for the purpose of EXPLOITING the above patent and ensuring its practical working in Great Britain.—All inquiries to be addressed to B. SINGER, Steger Building, Chicago, Illinois. 5578 H

THE PROPRIETORS of LETTERS PATENTS No. 166,833, relating to "Improvements in or relating to Mechanism for Drawing and Suspending Theatre Curtains, Cinematograph Screens and the like," No. 172,921, relating to "Improvements in or relating to Theatre Stages," No. 169,947, relating to "Improvements in or relating to Prosceniums for Theatres or the like," and No. 180,432, relating to "Improvements in or relating to Curtain or Screen-supporting Mechanism," DESIRE to DISPOSE of the PATENTS or to GRANT LICENCES to interested parties at reasonable terms with a view to the adequate working of the patents in Great Britain.

Inquiries to be addressed to AKTIEBOLAGET ALB, Kungsgatan 65, Stockholm, Sweden. 5560 H

THE PROPRIETORS of LETTERS PATENTS No. 13,362/14, relating to "Automatic Telephone Exchange Systems," No. 4295/15, relating to "Improvements in Automatic Telephone Exchange Systems," No. 100,115, relating to "Improvements in Automatic Telephone Exchange Systems," No. 121,474, relating to "Improvements in or relating to Electric Selectors for Telephone Systems," No. 121,967, relating to "Improvements in or relating to Group-switching Arrangements for Automatic or Semi-automatic Telephone Exchanges," and No. 186,593, relating to "Improvements in Selective Switching Devices," DESIRE to DISPOSE of the PATENTS or to GRANT LICENCES to interested parties at reasonable terms with a view to the adequate working of the patents in Great Britain.

Inquiries to be addressed to ALLMANNA TELEFONAKTIEBOLAGET L. M. ERICSSON, Dobelnsgatan 18, Stockholm, Sweden. 5570 H

MACHINERY, &c., WANTED

WANTED, PORTABLE ENGINE, 8-20 H.P. Export, 5594, The Engineer Office. 5594 F

WANTED, ELECTRIC CAPSTAN, 200 Vol. A.C., 50 P., rope or chain pollard head or both, speed about 5 m.p.h., load about six wagons, about 50 tons. Must be in first-class condition.—Address P8960, The Engineer Office. P8960 F

WANTED, Greenwood and Batley 24in. Stroke SHAPING MACHINE, in good condition.—IBBOTSON BROTHERS and CO., Ltd., Globe Steel Works, Sheffield. P8990 F

WANTED, ONE or MORE 1000-Ton POWER PRESSES, about 10in. stroke, 4in. adjustment table 40in. 60in. by 36in. 6in. Offers should state maker's name, condition and age of machines, and where may be inspected.—Address, 5566, The Engineer Office. 5566 F

WANTED, 15-20-Cwt. STEAM HAMMER, Cylinder 13in. to 15in. dia., 60 lb. pressure, single standard preferred.—Full particulars with price to W. G. BAGNALL, Ltd., Castle Engine Works, Stafford. 5444 F

LANCASHIRE BOILER, 20ft. by 6/8ft. dia. approx., complete with all mountings, for 160 lb. working pressure. Please state maker's name, details of mountings, price f.o.r., and where same may be viewed.—Address, 5557, The Engineer Office. 5557 F

MACHINERY WANTED.—WANTED TO PURCHASE for cash the following MACHINES, if in first-class condition:—

No. 12 Herbert PLAIN HORIZONTAL MILLING MACHINES.

Nos. 1 and 2 Herbert VERTICAL MILLING MACHINES.

UNIVERSAL and PLAIN MILLS, Cincinnati, Le Blond, and Milwaukee.

Brown and Sharpe AUTOMATICS, Nos. 00 G and No. 2 G.

BROACHING MACHINES.

Barber-Colman GEAR HOBBERS.

Nos. 2 and 13 Herbert BAR LATHES.

Address, 5558, The Engineer Office. 5558 F

SAND-BLASTING APPARATUS WANTED.—Write, Box 1248, Sell's Advertising Offices, Fleet-street, E.C. 4. 5571 F

AUCTIONS

G. R.

George Cohen and Armstrong

DISPOSAL CORPORATION,

OFFER FOR SALE BY

PUBLIC TENDER.

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at the

SOUTHAMPTON DEPOT.

The Material Includes:—

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8 Set Rolling Mills in two sets of 4 rolls, 14in. by 18in., 17in. by 18in., 15in. by 18in., driven by 400 H.P. slip ring motors, by Robertson and Co.

6 Set Rolling Mills in two sets of 3 rolls, 20in. diameter by 25in. and 18in. by 21in., by Robertson and Co.

2 Set Rolling Mills, by Robertson and Co., 12in. by 12in.

Spare Rolls, 18in. by 20in., 17in. by 18in., 16in. by 18in., 15in. by 18in., 15in. by 15in., 12in. by 12in., 24in. by 12in., 24in. by 30in., 20in. by 30in., 20in. by 24in.

3 Main-driven Gear Wheels for 12in. Mill.

Brass Bearings for 15in. to 24in. Mills.

Coupling Boxes from 12in. to 24in. ditto.

Guide Bars, Breaker Blocks, Wobblers for 12in. to 24in. Mills, &c., and numerous other Spares.

PLANT AND MACHINERY.

7 Sets of McDuff Muffle Furnaces.

9 Sets of Annealing Furnaces.

Crucible Furnaces, by J. Wright, 250 lb. capacity.

Crucible Lip Axis Tilting Furnaces, 18in. dia. by 2ft. 6in., bevel and worm gearing, by J. Wright.

Cast Iron Turntables for same.

Heating Furnaces (Greenhouse), by Lancaster and Sons.

5 Centrifugal Pumps, by Gwynne and Co., 2in. inlet.

4in. Belt-driven Vertical Pumps, by Evans, 34in. ram by 2in. stroke.

Vertical Well Pumps, by Evans.

Taylor and Challen Cutting and Capping Presses, daylight 71in. by 71in.

14 H.P. Semi-portable Steam Engine, by Marshall, Sons and Co., twin cylinder, 9½in. dia. by 12in. stroke.

Horizontal Compound Steam Engine, cylinder 9in. dia. by 14in. stroke, with Portable Steam Boiler, by Davey, Paxman.

Guillotine Shearing Machine, capacity 2in. by 1-16in.

Buckton Bar Shearing Machine, blades 14in. max. capacity, 3in. deep by 13in. wide.

18in. Double-ended Shears, by De Bergue.

3in. Double-ended Disc Punching Machine, by De Bergue, capacity 6in. dia. by 1½in. thick.

40in. Centrifugal Fans, by Keith, Blackman.

CRANES AND LIFTING APPLIANCES.

2-Ton Electric Jib Crane, by Stothert and Pitt, 35ft. jib.

15-Cwt. Morris Hand Block.

3-Ton Overhead Runway.

MACHINE TOOLS AND WOODWORKING MACHINERY.

9in. centre S.S. and S.C. Lathe.

5½in. centre Capstan.

14in. Slotting Machine; Power Grindstone, by Buck and Hickman.

30in. Band Saw, by Wilson and Sons.

24in. and 28in. Saw Benches, by Pickles.

18in. Double-spindle Moulding Machine, by Robinson and Sons.

ELECTRIC MOTORS AND ELECTRICAL MATERIAL.

Twelve 440 volts, 3-phase, 50 periods A.C. Motors, from 5 to 60 H.P.

Four 110 volts D.C. Ditto, from 12in. to 10 H.P.

1 D.C., 250 volts Ditto, 25 H.P.

Messer Testing Sets, 500 volts, 300 amps.

Electric Dynamometers, by Weston Electrical Inst.

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Electric Hot Cupboards, Hot Plates, Cookers, and Radiators.

Carbon Brushes, Porcelain Chandeliers, Fuses, Fuse Holders, and Insulators.

Resistance Coils, Bushes, Tumblers, Switches, 250 volt, Electric Lamps, &c.

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1400 Feet 55 lb. Crane Rails.

Large Quantity of Cast Iron Moulds, Plumbago Crucibles for 120 lb. and 250 lb. capacity.

Shafting, Pulleys, Blocks and Chain Slings, Iron Platform and Rails, 45in. to 61in. Shears, Tube Cutter and Expander, Steel Elevator, Trucks, Telephone Box, 2in. Steel Wire Rope, Guillotine and Cutter Blades, Iron Ladders, Sheaves for 5in. and 12in. cranes, 6 Pressure Gauges, Scales and Weights, Wire Cutters, Pick Helves and Heads, Shovels, Steamers, Saws (Metal), Screw Drivers, &c.

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Catalogue of sale and full Information from GEORGE COHEN and ARMSTRONG DISPOSAL CORPORATION, Abbey House, Victoria-street, S.W. 1. 'Phone, Victoria 8040. Telegrams, "Cohstrong, Sowest." 5560 J

By Order of Messrs. May and Butcher, Ltd., owing to reconstruction of business,

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Henry Butcher and Co.

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NEARLY NEW D.C. 220-VOLT ELECTRIC POWER PLANT:—

Three 40 K.W. vertical oil fuel generator sets and switchgear, by Campbell, Phœnix, and Lancashire Dynamo and Motor Co.

1 motor-driven 4-stage compressor, 9250 lb., by Peter Brotherhood.

1 ditto 12-ton capstan, by Grant; one 4-ton Ransome and Rapier ditto.

2 duplex salt water pumping sets, 95ft. head.

2 Vickers Stereophagus sewage pumping sets.

One 40 H.P. Armstrong-Whitworth electric motor.

One 20 H.P. Laurence-Scott ditto; one 10 H.P. Crompton ditto.

Two 60 H.P. Euston gas engines with gas plant.

Two 1500-gallon fuel tanks; 1 cooling tower, 300 H.P. capacity.

Two 4-ton Ransome and Rapier wharf cranes; one 30-cwt. ditto.

2 Herbert Morris overhead travelling cranes, 30 and 40 cwt.

1 Worthington triple-acting pump, 7in. and 5in. by 3in.; 1 steel chimney stack, 36ft. by 3ft.; 6 capstan jacks, 3 new benches, 24 portable forges, 40 smiths' anvils, 100 semi-rotary and other pumps, 20 corn crushers, large quantities of engineers', joiners' and other tools.

About 4 miles heavy copper cable on drums.

400 lengths I.R. hose, 150 ships' anchors, 500 ships' copper and galvanised lamps, 6 tons chains and slings, 3 tons hemp and cotton rope.

15 tons dubbin, 5 tons steel wire rope, 5 tons steel crowbars.

3000 new horse rasps, 10,000 handled wood mauls, 10,000 C.S. picks, 20,000 pick heives, 8 tons cut nails and spikes.

12 tons new dies, 9in. to 18in.

20 Weston's pulley blocks, 3 barge boats, 500 ash oars, 40 tons steel rails, &c., &c.

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TO BE SOLD BY AUCTION BY

Paterson and Thomas,

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FREEHOLD FACTORY PREMISES

in KNOWSLEY-ROAD, BOOTLE,

together with offices, land, and 3 dwelling-houses,

TOTAL SITE AREA

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VACANT POSSESSION

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EYOT WORKS, EYOT-GARDENS,

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Floor area about 19,500 sq. ft.

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VALUABLE FREEHOLD FACTORIES, WITH VACANT POSSESSION.

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342 SHARES of £100 each in CALDWELL and CO. and CALEDON ENGINE WORKS, 130, ELLIOT-STREET, GLASGOW. The capital of the company is £40,000 divided into 400 shares of £100 each.

Further particulars can be obtained from the subscribers, by whom offers will be received till 30th April, 1924.

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THE WHOLE OF THE

MACHINERY, TOOLS, PLANT,

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ALL MODERN TOOLS, Overhauled and Cheap:—Vertical Three-throw Heavy Pressure Pump, by Pearns; No. 5A Potter and Johnson Chucking Auto. £125; 5ft. Fosdick (Tapping) Radial Drill, £120; 14in. and 24in. Pillar Shapers; Surface Grinders, Reed Bros. (U.S.A.), £55; Tool and Cutter Grinders, Jones and Shipman; 3in. Power Presses, Taylor and Challen; Auto Gear Cutters for small spurs; Planishing and Riveting Power Hammers; Drills, 26in./28in.; Single and Three-spindle Sensitive and Geared Drills, from £8; Millers (Universal) No. 2 B. and S. and Cincinnati, from £90; Vertical and Lincoln Type Millers; High-speed Gap and Toolroom Lathes, 6in./24in.; Capstans, wire feed, 1in. (Ward), 1¼in.; High-speed Hack Saws; No. 2 Giant Raymond, &c.—DOWNING, 12, Lozells-road, Balsall Heath, Birmingham. 5356 C

A SQUITH RADIAL DRILL, 4ft. Arm; almost new.

14in. centre, Ward, Haggas and Smith LATHE, length of bed 20ft., change gear feed box; complete with all accessories; new condition.

Pollock and McNab HEXAGON PLAT TURRET LATHE, 2½in. hollow spindle, all-geared, multi-pulley drive, full equipment; practically new.

Several other high-class SECOND-HAND MACHINES IN STOCK.

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For continuation of For Sale Advertisements see page 3.

A Seven-Day Journal

Railway Orders.

SOME locomotive and rolling stock orders of considerable interest and value have been placed in this country within the past few days. The North British Locomotive Company, Limited, of Glasgow, has been successful in its tender for ten locomotives, at £76,000, for the West Australian Railways. The Vulcan Foundry Company, of Newton-le-Willows, has received an order for 40 heavy engines for an Indian 5ft. 6in. line. Orders for twenty-nine suburban trains, representing a total cost of £674,250, have been placed by the London and North-Eastern Railway. These orders have been distributed among the Metropolitan and Midland Wagon companies, Clayton Wagons, Cravens, Hurst, Nelson, and Pickering and Co., Limited. The India Stores Department has placed an order for 810 wagons; 600 of these wagons will be built at Birmingham and 25 in Scotland. The remaining 185 are to be built in Germany.

War Material Sales.

ACCORDING to a report made by Sir Howard Frank, chairman of the Disposal and Liquidation Commission, the total value of the war material sold up to December 31st last year reached just under 330 million pounds. During the financial year 1923–24 some 23 millions were handed over by the Commission to the Treasury by way of the net sum realised by sales effected in the twelve months. The sales, it would seem, have, in spite of the evidence of the shop windows, been made with a considerable eye to profits. On the whole of the transactions carried out, a net profit of about 78 million pounds is estimated to have been secured. Of that sum, approximately 44 millions have been handed over to the Exchequer, the balance of 34 millions having been divided among the different Dominions in accordance with a profit-sharing scheme.

Southampton Floating Dock.

ON the morning of Thursday last, the 17th inst., the large floating dry dock constructed by Sir W. G. Armstrong, Whitworth and Co., Limited, for the Southern Railway Company, left the Tyne under charge of tugs for Southampton. Leaving the builder's yard at seven o'clock in the morning in tow of ten steam tugs, the massive structure was skilfully guided through the comparatively narrow channel of the Tyne, and by nine-thirty the Shields Bar was passed. Once in the open sea, the dock was towed by seven tugs. It was practically in sight of land throughout the whole trip. With the unusually fine weather conditions which prevailed, Southampton was safely reached in four days, an average speed of 5½ knots being maintained. The dock has now been moored at the berth specially prepared for it. As designed, it has sufficient length and lifting power to dock either the Majestic or the Leviathan, the two largest vessels calling at the port, and, further, the design is such that the dock may be increased in length should future developments require it. The new dock is 50ft. longer and 70ft. wider than the Trafalgar graving dock at Southampton. It was described in THE ENGINEER of October 20th, 1922, and again in the issue of February 22nd last.

A New Underground Route.

THE City and South London Railway has now been linked up with the Hampstead line by means of a new tube extending from Euston to Camden Town, a distance of 1 mile. Whilst the work was proceeding the northern section of the City and South London Railway from Euston to Moorgate underwent entire reconstruction. On Easter Sunday, April 20th, a through service of trains was run between Hendon, Golder's Green, Highgate and the City. Later in the year the remaining portion of the City and South London Railway from Moorgate to Clapham Common will be completed, and will be reopened for traffic. Most of the stations are being entirely rebuilt, and are being provided with escalators. It is expected that the further extension of the Hampstead line beyond Hendon to Edgware will be finished in July. Tenders are said to have been invited from several important engineering firms for the work of extending the City and South London Railway from Clapham Common to Morden. The work will involve a total expenditure of £5,000,000, and will take approximately two years to complete. The new tube railway will be the means of opening up large tracts of country.

Electricity Plant Extension.

AN important test case relating to the extension of plant in an electric generating station, was recently settled in the Chancery Division, London. Representing the Electricity Commissioners, the Attorney-General said that the Ealing Corporation had extended its plant without obtaining the permission of the Electricity Commissioners as laid down in the Electricity Act of 1919. The case, he said, was to be regarded as important because of the difficult position in which the Commissioners would find themselves if authorities owning electricity undertakings were at liberty to alter the capacity of their stations without consulting the Commissioners, whose duty it was to regulate the supply in different areas. The corporation's defence was that the plant had not really been extended, for although new plant had been installed it actually occupied less space than that which had been removed. Mr. Justice Romer held, however, that there had been an extension, and made the declaration asked for by the Attorney-General.

Belfast Shipyard Labour Conference.

IN connection with the local engineers' demand for increased wages a conference took place at Belfast on Thursday last between representatives of the Belfast shipbuilding firms and the Amalgamated Engineering Union. The question at issue was discussed at some length. We gather that the representatives of the shipbuilding firms were desirous of promoting, if at all possible, an amicable settlement of the questions in dispute, and to this end an adjournment of the conference until April 30th was requested. In the meanwhile an assurance was given that the boards of directors of the various undertakings would be consulted, and when the conference was again resumed, it was hoped the firms' representatives would be in a position to make a definite proposal which might prove acceptable to the men.

The London Tube Subsidence.

ON November 27th last year, it will be recalled, an alarming, but fortunately nothing more than an alarming, incident occurred on the City and South London Tube Railway near the Borough Station. The railway since August, 1922, had been in course of reconstruction, but a service of trains was being maintained during the day-time, the work on the tunnels being carried out at night. At about 5 p.m. on November 27th a train from Clapham Common, travelling at a speed of 15 miles an hour towards the Borough Station, struck some boards projecting from the roof of the tunnel. It managed, however, to get clear of the spot before a subsidence, of which the projecting boards were the first sign, and which ultimately extended to the street above, occurred at the point. Lieut.-Colonel Mount's report to the Ministry of Transport, dealing with the mishap was published on Tuesday. The subsidence, in Colonel Mount's opinion, was caused by the combined effects of "insufficient cover of homogeneous clay under the water-bearing gravel, the consequent presence of water and the vibration caused by passing trains." The actual collapse in the centre of the roof he regards as being possibly the result of "inadequate thickness and insufficient bearing of the poling boards to withstand the excessive pressure."

Empire Exhibition Honours.

ON the occasion of the opening of the British Empire Exhibition, his Majesty the King intimated his intention of conferring a Peerage of the United Kingdom on Sir James Stevenson, chairman of the Standing Committee of the Exhibition, and to appoint as Knight Commanders of the Civil Division of the Order of the British Empire, Mr. J. W. Simpson, the principal architect, and Mr. E. O. Williams, the principal engineer. Sir James Stevenson was intimately connected with the Ministry of Munitions during the war and after the Armistice served his country voluntarily in a variety of capacities connected with demobilisation, reconstruction, civil aviation and the regulation of rubber production. Mr. Simpson is a Fellow and a Past-president of the Royal Institute of British Architects, and has designed many important public buildings and memorials. Mr. Williams is a civil engineer who has largely specialised in reinforced concrete work. He is an Associate of the Institution of Naval Architects and an Associate Fellow of the Royal Aeronautical Society. He has been connected as an engineer with the construction of the Bush Terminal Building, Aldwych, London, and of the Phœnix Works and Wharves at Port Talbot. The first concrete ship designed during the war was built under his supervision.

The White Star Liner Homeric.

THE White Star liner Homeric, which has recently been converted from coal to oil burning, left the Belfast yard of Harland and Wolff, Limited, on Saturday last and arrived in Southampton on Monday morning. She is scheduled to take up her New York sailings on the 30th of the month. A feature of the extensive overhauling and reconditioning work which has been so successfully carried out was the original lack of information concerning the construction of the ship, which was one of the vessels handed over by Germany by way of reparations. It was, therefore, necessary to obtain particulars during her stay in port between voyages, and this preliminary work was done last season, so that a considerable amount of the necessary material required for reconstruction might be prepared beforehand. Altogether, thirty-seven separate tanks have been built in, carrying in all some 5050 tons of fuel oil. The oil-burning system is of the latest pattern, special facilities being provided for rapid bunkering. With a view to reducing the viscosity of the fuel oil during the cold seasons on the North Atlantic route, steam heating coils are provided in each oil fuel bunker. An oil separator of patented design deals with the oily-ballast water. Now that the Homeric has been converted to oil burning, it may be expected that the more steady steaming which should be realised will tend to improve her speed records. Opportunity has been taken to improve and re-arrange parts of the passenger accommodation, so that the Homeric is now, without doubt, one of the best equipped and furnished vessels in the Atlantic service.

Canadian Helium.

DURING the war, as is well known, the British and American Governments took an active interest in the discovery and exploitation of sources of the gas helium with the object of employing it in place of hydrogen in airships. In the United States a fairly satisfactory source was found in the natural gases from oil wells, and processes were devised whereby the small content of helium contained in these gases could be isolated and stored for use. To-day, the quantity available is sufficient to supply the gas required by the airship Shenandoah, which vessel has given on several occasions a good account of herself on helium. An investigation of the British Empire's resources in helium was undertaken in 1915, and it was found that natural gas from the Bow Island field, Alberta, was the richest source available with one-third of 1 per cent. content. Within the past twelve months the Canadian Department of Mines has been making another survey of the Dominion's helium resources and has been collecting and analysing samples of natural gas. Natural gas has been found only in Alberta and Ontario. Several of the Ontario gases show a helium content of a little less than one-third of 1 per cent. The Alberta gases, however, would seem to offer the best chance of commercial development. A new source 40 miles south of Bow Island has given 15 million cubic feet of natural gas per day with a helium content of 0.2 per cent. The Department estimates that the Alberta gas might be made to yield about 15 million cubic feet of helium per year.

The Shipyard Dispute.

FOLLOWING the decision of the Southampton shipyard workers to resume operations on condition that a conference with the employers was held immediately to secure uniformity between the Southampton and London rates of wages, the Federation of Shipbuilding and Engineering Trades met on Wednesday of last week and concurred in the proposals which its representatives had made to the strikers. Subsequently the executive of the Federation met the employers with the objects of reporting the proceedings and of endeavouring to arrange the desired conference. The employers expressed their willingness to meet in conference in London as soon as the men had resumed work, but they declined to express beforehand any opinion on the men's claims. It was urged upon the Southampton workers that they should restart on the following day, Thursday, in order that the lock-out notices might be withdrawn at once, and so permit the immediate re-employment of their fellows at those yards in Scotland and elsewhere which do not observe the Easter holiday. The general body of the Southampton strikers, however, could not see their way clear to do so without holding yet another mass meeting. The members of the Transport and General Workers' Union, however, resumed their work on Friday, and as a result the lock-out notices against the members of this union in other parts of the country were immediately withdrawn. The rest of the strikers resumed work on Wednesday and on that day the general lock-out notices were withdrawn.

The Gas Referees' Reports.

THE quarterly reports issued by the Gas Referees under the Gas Regulation Act of 1920, giving the results of the testings carried out on the gas supplied by the six companies in the London area during the first three months of this year, have been received since our last issue. They reveal the fact that all the companies are now working much more closely to their prescribed calorific values than they were a short time ago. The Gas Light and Coke Company has always succeeded in doing justice to itself in this respect, and on this occasion has cut things to a still finer margin, its prescribed value being 500 B.Th.U. per cubic foot and its average realised value 500.7. All the other companies show average realised values which exceed the prescribed values by five, or just under five, units per cubic foot. The South Suburban Company, which some months ago was particularly generous in supplying its consumers with a richer gas than it was allowed to charge for, is now working with an excess richness of little more than 1 per cent.

G

The British Empire Exhibition.

ENGINEERING EXHIBITS, No. 1.

INTRODUCTION.

In opening this series of articles on the engineering exhibits at Wembley it seems desirable to say a few words by way of introduction. We have as yet only a vague conception of the amount of material to be covered, but already we know well enough that to do justice to it all is quite out of the question. Several big volumes were required to hold the official account of the more notable machines, appliances and material at the Great Exhibition of '51. It is only necessary to think of the enormous developments that have taken place since that time to appreciate the space that we should have to devote to the Exhibition did we attempt to cover completely even no more than those sections in which we are directly interested. The alternative would be to describe only what is new or exceptional. But that would be to do scant justice to engineering manufacturers. By far the greater bulk of the exhibits are familiar to us, yet not to mention them, not to illustrate and describe them, would give readers of our articles a false impression of the contents of the Exhibition and would rob British engineers of that help in their industry which it is our pleasure and privilege to give them. We shall therefore in these articles wander over the exhibits, giving to some more attention than to others, but throughout seeking to set before our readers such a picture of the Exhibition that they may gain a just idea, not only of its contents, but of the proud position occupied by engineering in the Empire.

A little later, when the Exhibition has settled down to its routine, we shall endeavour to take some of the exhibits in classified groups, but for a week or two that course is not practicable. For one thing, it has been physically impossible to examine more than a few of the stands, and, following our usual practice, we prefer to write from personal knowledge than from descriptions supplied to us by manufacturers; for another, at the time of a visit just before the Easter holidays many of the stands were incomplete and others were swathed in canvas, whilst the opportunity to get more than a general impression after the opening on Wednesday was out of the question. In a week or two the exhibitors will get down to business, and it may then be possible to give up the random arrangement that has been followed in the article we present to-day and adopt a more logical plan.

The Palace of Engineering.

The building in which the engineering exhibits are housed is an immense structure of ferro-concrete and glass. Its exterior is very reserved, not to say austere, and its interior has no architectural charms beyond those associated with spaciousness. It is a little irregular in plan, with a maximum length of 950ft. and a maximum width of 725ft. It is divided into eleven longitudinal bays, of which five, occupying the central portion of the area, are 75ft. wide, whilst the others are 50ft. wide. There are no galleries and the height to the lower members of the roof principals of the big bays is about 41½ft. Railway tracks of standard gauge run the whole length of the five 75ft. bays, which are also served by 25-ton overhead cranes. The railway tracks are laid in permanent channels, which are now boarded over. Owing to this excellent arrangement heavy machinery was got into position with quite surprising quickness, and when the time comes will be removed with equal ease.

The floor area of this great hall measures nearly 15 acres and is occupied by two sections, one of which was organised by the British Engineers' Association and the other by the British Electrical and Allied Manufacturers' Association. The latter includes all exhibits by electrical firms and the former all those by firms engaged in all kinds of mechanical engineering and shipbuilding. In this section over four hundred firms are represented on 278 stands in an area of nearly 255,000 square feet, whilst the B.E.A.M.A. section covers about two hundred firms on 170 stands and occupies about 130,000 square feet. There is, furthermore, an important section devoted to motor cars and land transport generally.

Congresses.

In connection with the Exhibition a number of congresses and technical meetings will be held, many of which will be of direct interest to engineers. Amongst them we may mention four meetings of the British Engineers' Association, the first on May 21st; the World Power Conference, June 30th to July 12th; a congress of the Institute of Mining and Metallurgy, June 3rd to 6th; a meeting of the Institution of Automobile Engineers, June 23rd, of the Institution of Municipal and County Engineers, on June 28th; of the Institution of Mechanical Engineers, on July 8th and 9th; of the Incorporated Municipal Electrical Association, on September 17th; and of the Institute of Transport, on September 19th. The World Power Congress will probably be the most important of these conferences, as it is understood that representatives from all parts of the Empire as well as from foreign countries will collect for it. The meetings will be held in the Conference Hall, which adjoins the Palace of Industry.

Broadcasting Arrangements.

For broadcasting the King's speech to the auditorium of the Stadium the Western Electric Company's public address system was used. The King spoke into a transmitter suspended from the roof of the Royal pavilion, and the weak speech currents were led through shielded leads to amplifiers in a control room. The amplified currents were led out to the receiver projectors, which were carefully arranged in the pavilion roof to deliver the sound to the huge audience in the Stadium. The transmission of speech without distortion entails the picking up by the transmitter and amplification and reproduction by the receivers of all frequencies from 200 to 6000 with uniform efficiency. These figures represent extremely exacting conditions, as it is very difficult to make telephone apparatus operate over so wide a range with as little distortion as is given by the valves. It is, however, permissible to have variations in the intensity of reproduction at different frequencies, provided that the total variation is not more than that produced by 10 miles of standard cable. The diagram Fig. 3 shows on the left the transmitters, the output current from which is taken to a switching panel, where means are provided for cutting in the various transmitters. From this panel the transmitter currents are taken to the transmitter or speech input amplifier, which amplifies them to a power level suitable for input to the power amplifier. The output from the power amplifier is taken through a panel where switches and a multi-step auto-transformer are provided for the regulation of several projector circuits. Above this panel is a volume indicator designed to register the volume output to the projectors.

The transmitter which is employed—see Figs. 1 and 2—consists of a heavy steel ring supporting a tightly stretched duralumin diaphragm less than $^{2}/_{1000}$in. thick. On each side of the diaphragm is a small chamber containing carbon of special quality. This arrangement enables the asymmetric distortion, inherent in carbon transmitters, to be eliminated by a process of neutralisation. On one side of the diaphragm a flat plate, with suitable perforations, is arranged close to the diaphragm in order to obtain high air damping. To guard the transmitter against vibration it is suspended by means of spiral springs inside a wire cage housing. When the speaker is at a distance of 5ft. from the transmitter the power output is about 10^{-3} watts. The amplifiers used in the address system installed at Wembley are the Western Electric Company's No. 8A and No. 10A types, and the equipments are mounted in panels of uniform width, so that they may be assembled on two vertical angle iron racks. The No. 8A speech input amplifier, shown in Fig. 4, is a three-valve three-stage apparatus having two potentiometers to provide adjustment. The filaments of the valves are supplied from a 12-volt storage battery, while the plate circuits are fed from a 350-volt direct-current supply. The correct grid potentials are obtained by utilising the drop over a resistance in the filament circuits of the first two valves, whilst for the third valve small dry cells are used for proving the grid potential. The No. 10A amplifier—see Fig. 5—is a four-valve apparatus supplying one stage of amplification, the valves being connected by a parallel "push-pull" system. The plate circuits are supplied with direct current at a pressure of 750 volts, and a 12-volt storage battery supplies the filament current.

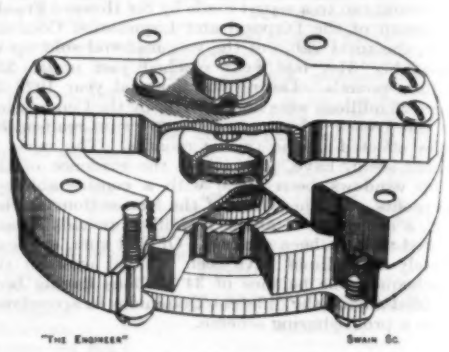


FIG. 2—DETAIL OF TRANSMITTER

Some device is necessary to give the operator control of the volume delivered by each projector or group of projectors, and the equipment designed for the work is mounted on a panel constructed to conform with the other panels. It consists of an auto-transformer connected across the output of the amplifier with eleven taps connected to the contacts of eight dial switches. Seven of the dials control projector circuits on each of which one or more projectors may be grouped, and the eighth dial is reserved for controlling the operator's monitoring projector in the control room. Each dial is provided with a key for opening the circuit, and a master key is also provided for cutting off all of the projectors simultaneously.

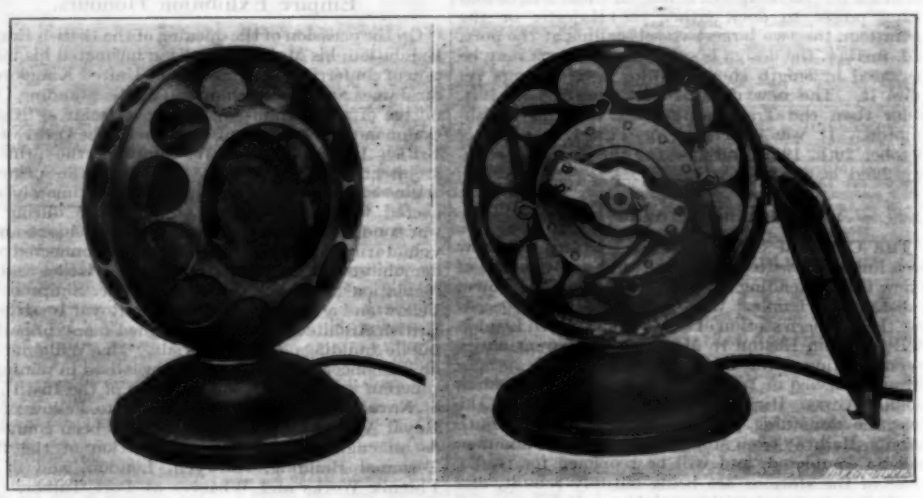


FIG. 1—THE TRANSMITTER

The volume indicator consists of a valve detector bridged across the output terminals of the power amplifier, and the rectified current is taken to a sensitive direct-current meter of the moving coil type, the degree of deflection of this meter measuring the output from the power amplifier. The power is taken from the control panel to the projectors, each consisting of a loud-speaking receiver and a distributing horn. The receiver is designed to carry several watts without distortion and operates on the balanced armature principle. A light spring-supported iron armature is mounted between the poles of a permanent magnet and passes through the centre of the coils which carry the voice currents. One end of the armature is attached to a light connecting link which is fixed to the centre of an impregnated cloth diaphragm which is corrugated to permit vibrations

of large amplitude. The receiver is provided with a metal cover and a cast iron case for protection.

To meet the various conditions under which the public address system is used three types of horns have been designed. For projecting sound to great distances a tapering wooden horn 10½ft. long and having a rectangular cross section is employed, the sides being braced to prevent lateral vibrations. Large projectors of this type have been fitted up in the roof of the Royal pavilion for covering the huge area of the Wembley Stadium. For smaller installations a smaller type of fibre horn of the straight cone pattern and flaring open end is employed.

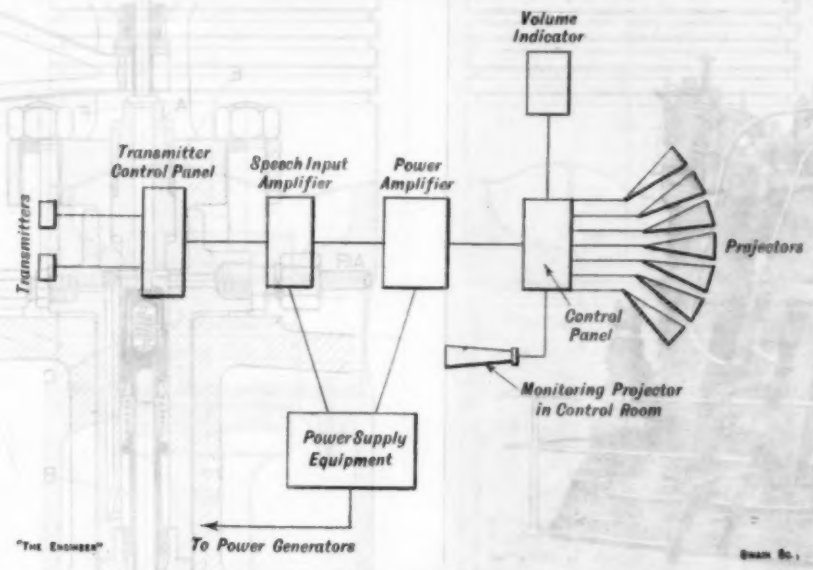


FIG. 3—ARRANGEMENT OF PUBLIC ADDRESS SYSTEM IN THE STADIUM

It will be realised that it is absolutely essential to design each part of the equipment for distortionless reproduction of the wide band of frequencies to be dealt with. The enormous magnification makes this very essential, and from the above description it will be seen how this problem has been met and successfully solved. In order that owners of receiving sets in various parts of the United Kingdom might hear the King and the Prince of Wales speak, the British Broadcasting Company made suitable arrangements for receiving the speech, and after amplification for transmitting it through a wire to the Strand, whence it was by the customary means radiated from Marconi House.

The transmission proved entirely successful, and great credit is due to the Western Electric Company and the British Broadcasting Company for the way in which the work connected with the experiment was carried out.

GENERAL ENGINEERING EXHIBITS.

Mirrlees, Bickerton and Day, Limited.

A notable exhibit of oil engines at Wembley is that shown on the stand of Mirrlees, Bickerton and Day, Limited, of Stockport. With a view to making an appeal not only to engineers who have specialised in internal combustion engine work, but also to other engineers and visitors who may be desirous of obtaining a knowledge of the working of oil engines, special care has been taken to present the exhibits in an attractive manner. Thus each engine shown has certain parts cut in sectional form, which enable the working principle and the details of construction to be seen and studied. Further than this, arrangements have been provided whereby the engines are rotated slowly by an electric motor with a friction pinion engaging with a surface of the fly-wheel. This special turning gear will be seen in the illustrations reproduced in Figs. 6 and 12. We may perhaps comment on the very careful and excellent way in which the sectioning of the various parts has been carried out. The illustrations accompanying this article show some of the more important details, and it would appear that all the engines shown are worthy of close study.

Briefly the outstanding features of the exhibit may be enumerated as follows. A three-cylinder standard type 150 brake horse-power Mirrlees Diesel engine; a new 40 brake horse-power Mirrlees-Simplex engine; and parts of a Mirrlees-Nobel engine designed for 1000 brake horse-power. In addition, the firm is showing two of its 3½ brake horse-power petrol-paraffin engines, one connected to a lighting set and the other driving an air compressor. A number of engine details and several examples of the new Mirrlees mechanical lubricator are also exhibited.

The engine, which we illustrate in Fig. 6, represents one of the firm's standard 150 brake horse-power engines, a type of prime mover which has achieved well-deserved success, both at home and abroad. From the view given it may be noted that the top part of No. 1 cylinder—that furthest away from the fly-wheel—has been cut away to show the construction of the uppermost part of the cylinder casing, the cylinder cover and the valve casings. This particular part is perhaps more clearly illustrated in Fig. 7. In Fig. 8 we show two views of the sectioned fuel pump. The sound, yet quite simple construction of this important part of the engine will be appreciated, as will also the facility with which access to the valves and other parts is given, which greatly eases the task of inspection and keeping the valves in order. While many improvements have from time to time been made in various constructional details, particular mention may be made of a new patented fuel valve shown for the first time, which dispenses with the need for fuel valve packing. The new valve would thus appear entirely to remove one of the objections sometimes raised in connection with Diesel engines, namely, careless packing or tightening down, which may cause the fuel valve to stick, and by so doing permit fuel to enter the cylinder before its proper time, causing pre-ignition and cylinder pressures considerably higher than those occurring during normal working. The diagrammatic drawing—Fig. 9—will serve to indicate the main features of this new fuel valve. It has the merit of being simple in construction and may, we learn, be applied to all existing engines. Referring to Fig. 9, it will be noted that the new "packingless" fuel or needle valve consists of two main parts, an upper part A and a lower B. These are joined together by means of a double ball and socket joint C. The provision of this joint removes the necessity for the absolute alignment of the upper part of the valve with the lower; hence should it happen that one of the bolts D securing the fuel valve casing is unequally screwed down, tilting the upper casing and causing a slight error of alignment, this error will not affect in any way the proper working of the fuel valve.

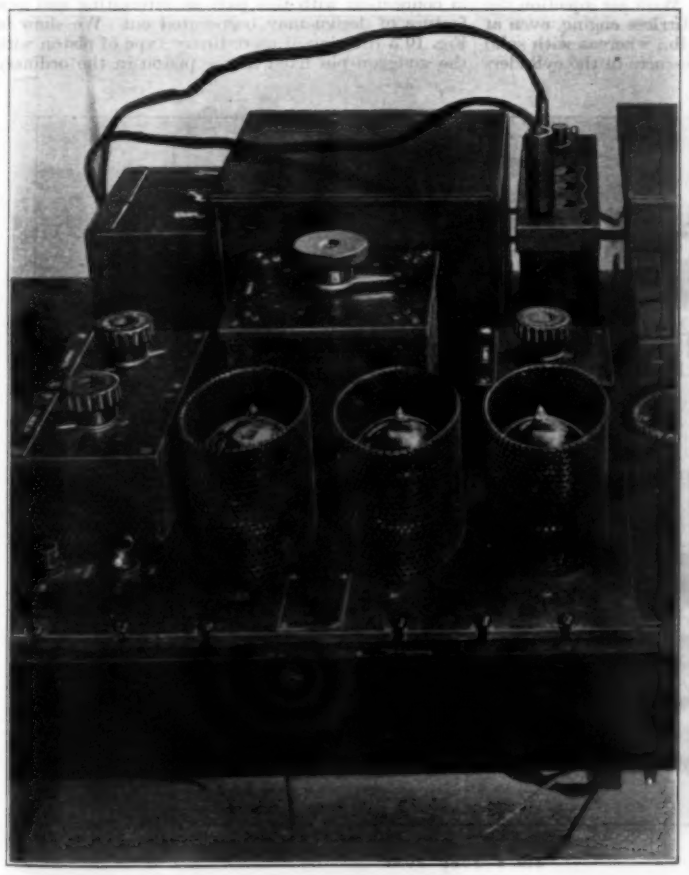


FIG. 4—SPEECH INPUT AMPLIFIER

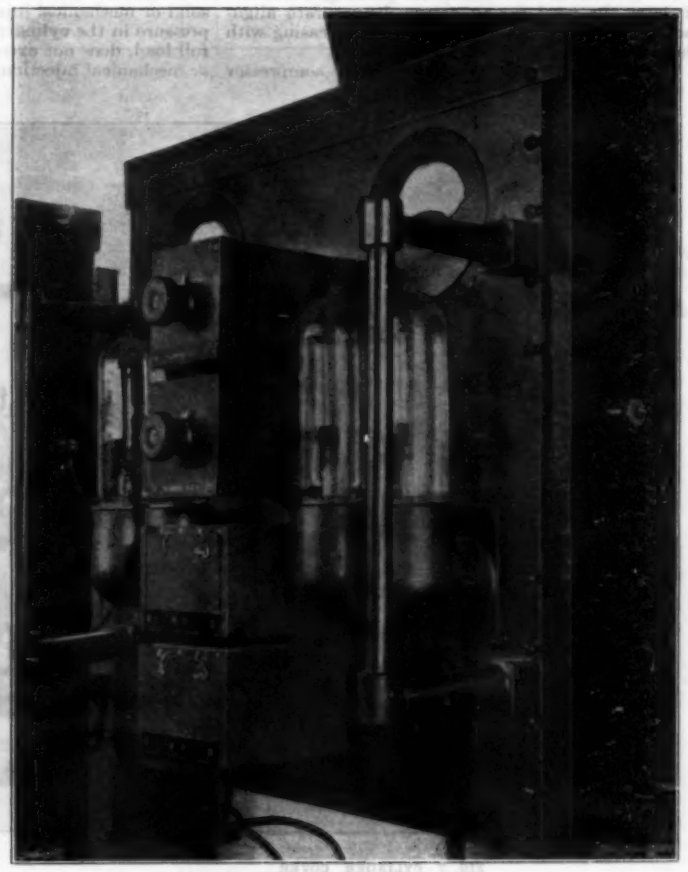


FIG. 5—POWER AMPLIFIER

At the top of the upper fuel valve casing a valve face F resting on a lower seating will be noted. It is this face which prevents air leakage past the fuel valve. When the valve face is in position on its seating the lower end of the fuel valve also rests on its conical seat above the flame plate. To ensure accurate seating a slight amount of play is allowed between the top and bottom face of the fuel valve spindle, and furthermore

a spring is provided between the two parts of the valve stem.

When the valve lever lifts the fuel valve spindle the top valve face F already referred to is raised from its seating and any air leakage then depends on the quality of the fit of the fuel valve spindle in its bush. The lifting period constitutes, however, only a fractional part of each stroke, and the makers inform us that any leakage past the spindle which may occur during these very short intervals of time is quite negligible. From the description we have given it will be appreciated that the new design of fuel valve not only removes the necessity for packing, but it also obviates the need for an extremely accurate alignment of the upper part of the fuel valve casing with the lower part.

The illustration Fig. 11 depicts an air compressor very small sizes of engine air compressors are required for supplying the air for starting mechanical injection engines.

Messrs. Mirrlees, Bickerton and Day claim that the injection of the fuel oil into the cylinder by means of compressed air, not only has the advantage of having been proved highly satisfactory for over twenty-five years, but that it is still the best system of fuel injection, for with it no adjustment of pulverisers is required even for wide variations in quality of fuel oil, complete freedom from smoke at all loads is secured, and the working pressures in the cylinders are much lower than in cold-starting engines which use solid or mechanical injection. With air injection the pressure in the cylinder of a Mirrlees engine, even at full load, does not exceed 480 lb., whereas with solid or mechanical injection the pressures in the cylinders frequently exceed 600 lb. Consequently, for a cylinder of any given dimension using solid injection, the working parts should be larger and stronger than for a Diesel engine.

It has in the past been claimed that higher pressures than 480 lb. may from time to time occur in a Diesel engine cylinder owing to the sticking up of a fuel valve. The new type of packingless fuel valve we have just described eliminates this difficulty, and with its adoption there should be no chance of high cylinder pressures caused by fuel valve sticking or holding up.

We may also call attention to the method of lubricating the engine cylinders. In the past most Diesel engines and even other types of oil engines have been fitted with a cylinder lubricating system in which one pump supplied oil under pressure to several points on each cylinder. The experience of the makers of Mirrlees engine has shown that such a system does not definitely ensure a proper supply of oil being given to each point of the cylinder. They have therefore adopted a special form of forced feed lubricator which is connected to each individual point on the cylinder.

Turning to the lower part of the engine cylinder, we also noted that the cylinder is sectioned so that its construction and the method of fixing the liner is clearly seen. The piston is also shown in section, and in connection with this part an interesting and new feature of design may be pointed out We show in Fig. 10 a drawing of an ordinary type of piston with the gudgeon pin fixed in the piston in the ordinary sectioned in the manner we have previously described. It is fitted with silent disc valves and its general construction, it will be noted, is simple in character. The air compressor is an important unit which must be built for reliable service over prolonged periods. When comparing Diesel engines using air injection with similar engines working with mechanical injection the fact must not be overlooked that except for way, and alongside it the new Mirrlees piston with a floating piston pin. Comparing the two drawings it will clearly be seen that the new construction offers important advantages. These may be summarised as follows :—The bearing surfaces of the connecting-rod top end are substantially increased and the bearing pressures are consequently lower. The way in which the gudgeon pin is supported also greatly reduces

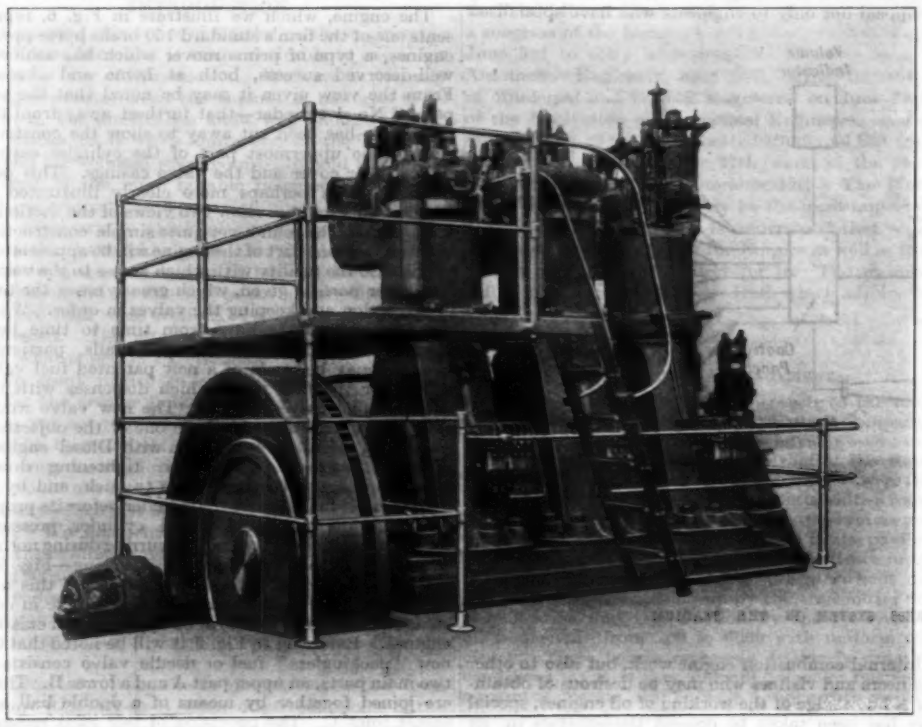


FIG. 6—150 B.H.P. DIESEL ENGINE—MIRRLEES, BICKERTON AND DAY

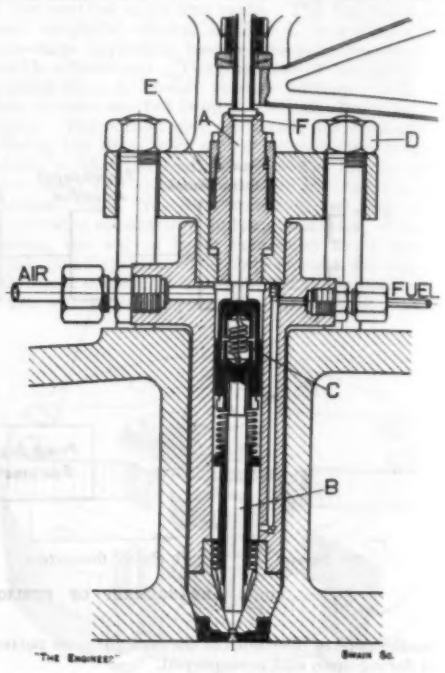


FIG. 9—FUEL VALVE

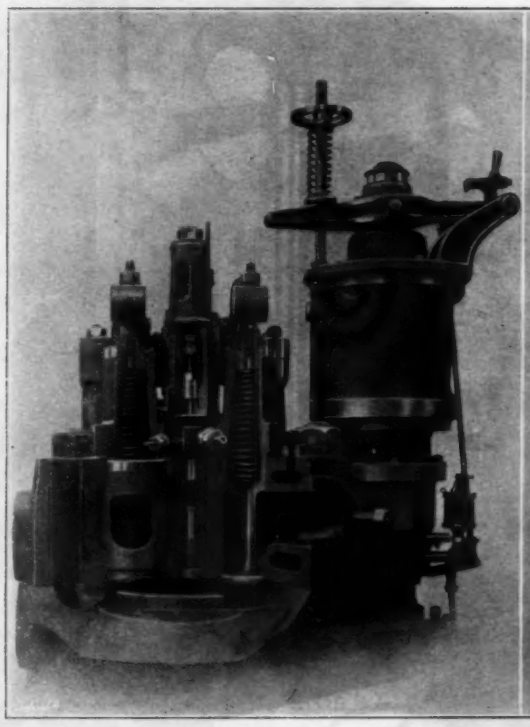


FIG. 7—CYLINDER COVER

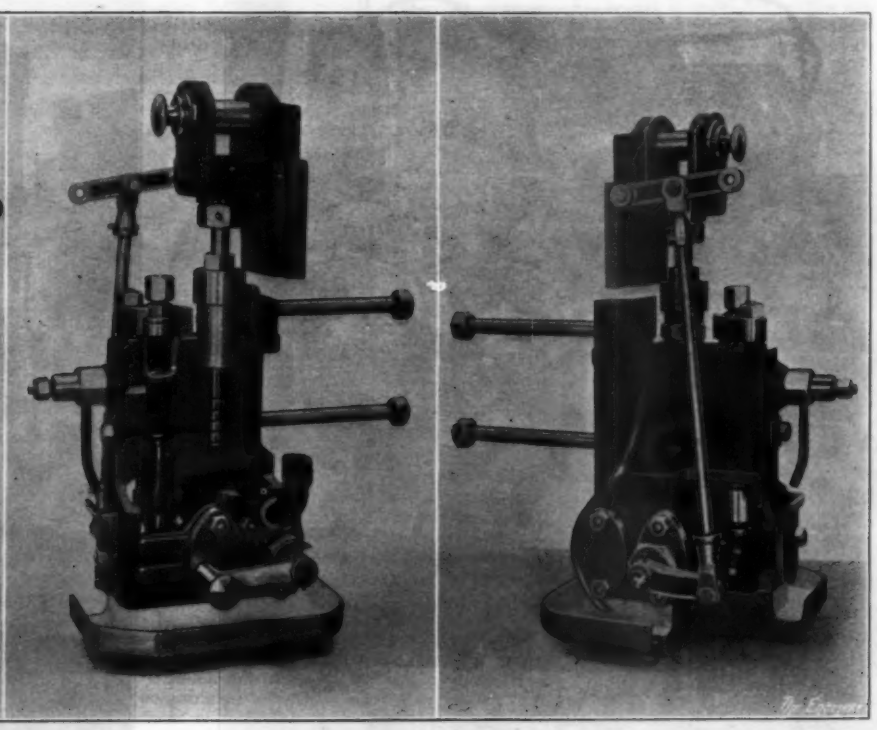


FIG. 8—FUEL PUMP

the bending stresses in the pin, which are, we are informed, almost completely eliminated. Another advantage is that with a floating pin any tendency of the pin to wear oval is done away with. Even more important than this there is no possibility of the piston becoming distorted from the heating of the pin or of it being forced out of position. The gudgeon pin is, moreover, very easily removed from the piston, since it is only kept in place by light retaining plates.

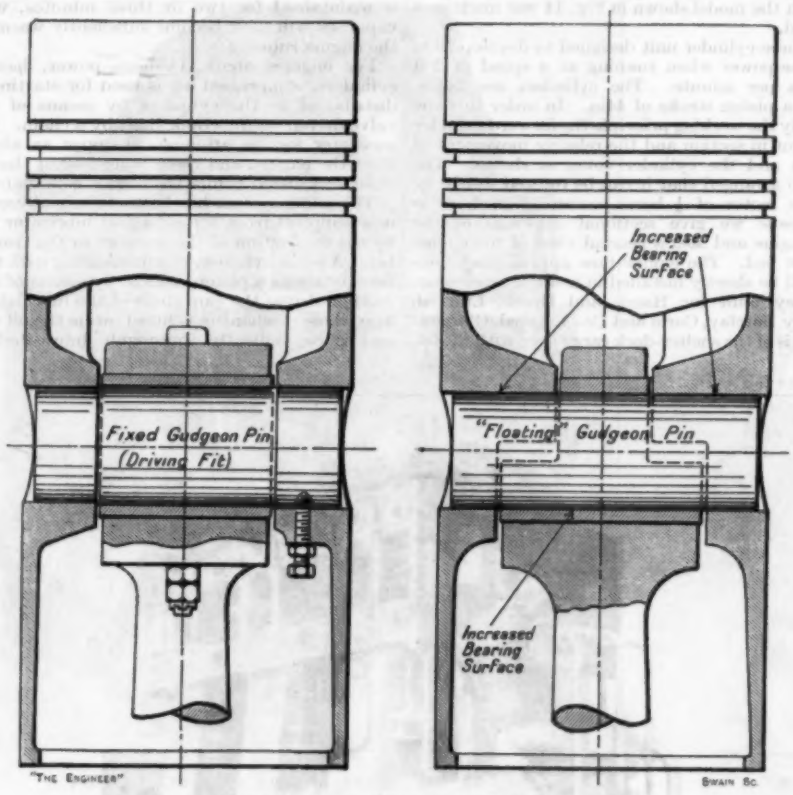


FIG. 10—OLD AND NEW TYPE DIESEL ENGINE PISTONS

So far we have dealt with Mirrlees engines of standard design, but the 40 brake horse-power Mirrlees-Simplex engine marks a welcome step in a new direction, and will, we believe, be the centre of much interest. The illustration we show in Fig. 12 gives a general view taken from the exhaust side. Like the engine already described, this exhibit is also sectioned to show the working parts and is furnished with slow-moving turning gear so that the cycle of operations may be studied. On the side shown in Fig. 12 part of the cylinder casing wall has been removed, uncovering the exhaust ports and outlets. This section also shows parts of the scavenging chamber, the cooling water spaces and the cylinder liner. On the far side of the engine a similar sectioned portion of the cylinder casing reveals the air inlet passages, whilst a piece cut out of the column allows the crosshead to be seen. A further opening in the splash guard allows the crank chamber to be inspected and exposes the forced lubrication pump and the governor.

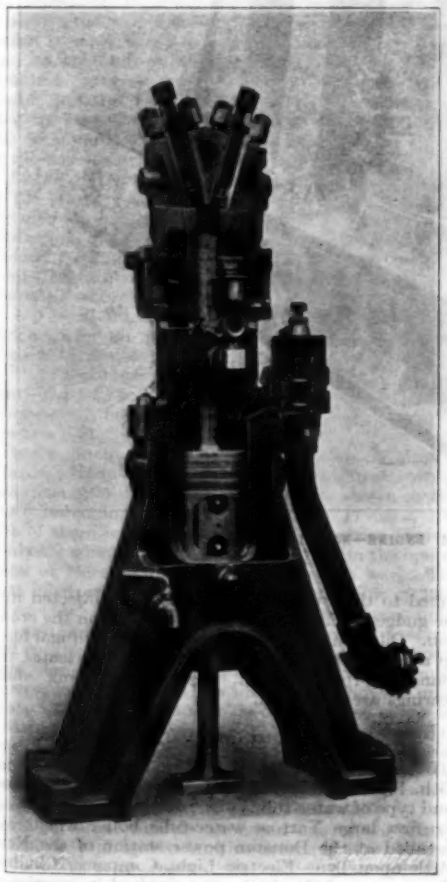


FIG. 11—AIR COMPRESSOR

A most important feature of this engine is the absence of crank case compression, which is so often used with two-cycle engines of the hot-bulb type. In the Mirrlees-Simplex engine the underside of the main piston serves as the piston of the scavenge air pump, but both the underside of the piston and the scavenge air chamber itself are completely isolated from the main crank chamber, a crosshead form of construction being employed. The sectional view we reproduce in Fig. 13 clearly shows the construction of the main parts. By separating the scavenge air chamber from the main crank case copious lubrication of all the bearings, including the guide bearing at the top of the connecting-rod, is permitted. The design used should prevent any lubricating oil being carried by the scavenge air from the crank casing into the cylinder, and furthermore, no splashing of the cylinder walls with lubricating oil can take place. Carbonisation of the piston and cylinder head spaces is, we learn, reduced to the absolute minimum.

A further advantage of the crosshead construction is that it prevents any deleterious matter from the cylinder contaminating the lubricating oil on the crank chamber, with the result that this oil remains quite clean and can be used over and over again for a long period.

From an inspection of the drawing we show, it will be recognised that the general design of the engine closely follows that which, owing to its proved reliability, has now become practically standard for high-speed steam engine practice. In fact, the only difference would appear to be that the oil engine cylinder replaces the steam cylinder. The Mirrlees Company has employed the crosshead system with forced lubrication on its large engines for a considerable period, and the experience gained in this direction has been applied to the Simplex design.

Some detailed particulars of the fuel pump and governor gear may now be given. The fuel pump is driven by means of an excentric on the crank shaft, while the pump casing is bolted direct to the crank chamber, so that the lever operating the pump, also the excentric, are in the closed chamber and are properly lubricated. A separate fuel pump unit is used for each cylinder, so that the multiple-cylinder engines will have a number of identical units, thus minimising the spare parts required. Water injection is used and by means of wedges, whose position is adjusted by the governor, the quantity of water injected into the cylinder is regulated to suit the load, and, in addition, the time at which the injection commences is automatically adjusted, for the makers' experience has shown that by suitably varying the time of the commencement of the injection, power at all loads, from no load to overload, can be satisfactorily developed without recourse to any form of artificial heating.

The wedge device used in the Mirrlees-Simplex engine enables any desired adjustment in the timing of the injection to be adopted by simply modifying the contour of the wedge. A considerable amount of experimental work has been done, we learn, in order to arrive at the best wedge contour, namely, at the best time to begin the injection of the oil. The results of this experimental work have been embodied, we are informed, in the engine. The governor is of the normal centrifugal type and is arranged to give close speed regulation for driving alternators and other steady running machines.

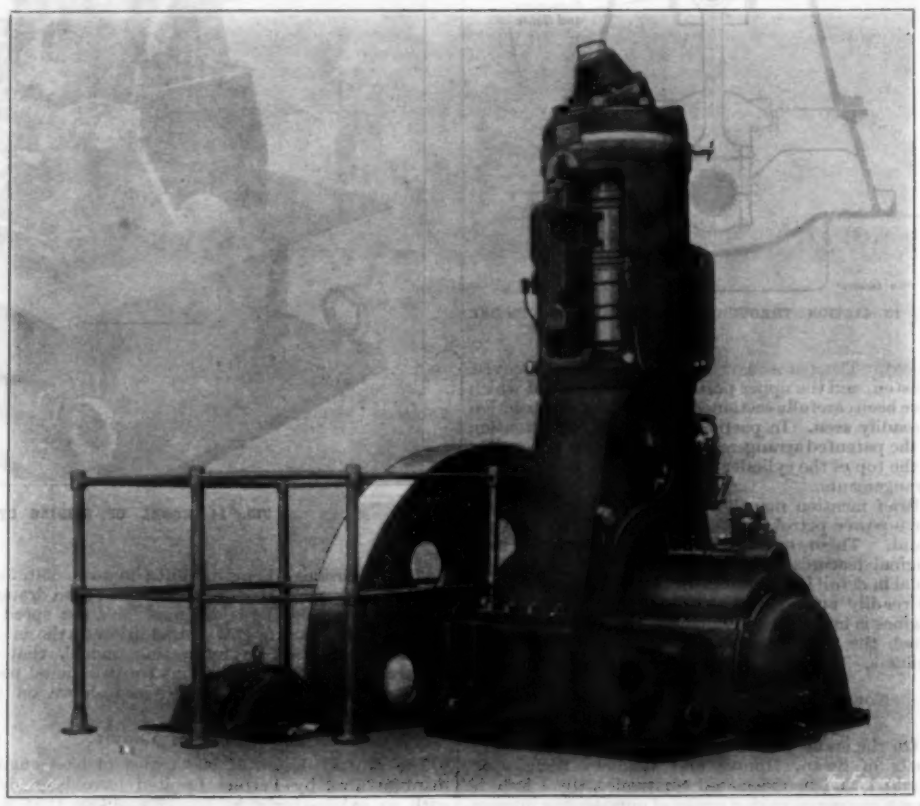


FIG. 12—40 B.H.P. TWO-CYCLE MIRRLEES-SIMPLEX ENGINE

Reference has already been made to the special mechanical system of cylinder lubrication used on the 150 brake horse-power engine. A similar system is employed on the Simplex engine, a separate lubricator being attached to each lubricating point. An examination of the engine goes to show that accessibility has evidently received very full consideration. Thus, when the cylinder cover is removed, the intermediate cover screws eased back, and the bottom end bolts of the connecting-rod taken out, the piston unit complete with piston-road, crosshead and connecting-rod can be lifted out.

In order to take out the piston it is only necessary to knock out the piston-rod cotter and remove the cylinder cover, after which the piston itself can be lifted clear of the cylinder. We are impressed by the general simplicity of the design, and the crosshead construction should certainly prove very advantageous for arduous service conditions.

It was announced some time ago that Mirrlees, Bickerton and Day, Limited, had acquired the rights to use the patents and designs of the Russian Nobel Company. It may be recalled that this firm of Russian engineers began to manufacture Diesel engines about twenty-six years ago, shortly after the first Mirrlees engine was built. Nobel engines have achieved considerable success for both marine and land work, and particular progress has been made with large marine engines of the two-cycle type. It was not found practicable to exhibit a complete 1000 brake horse-power unit of the Mirrlees-Nobel type, but some interesting portions of one of these engines are displayed. The parts shown include a cylinder cover, a piston, and the upper part of a cylinder, all of which have been carefully sectioned so that their construction is readily seen. In particular we may call attention to the patented arrangement for improving the cooling of the top of the cylinder and the piston water cooling arrangements.

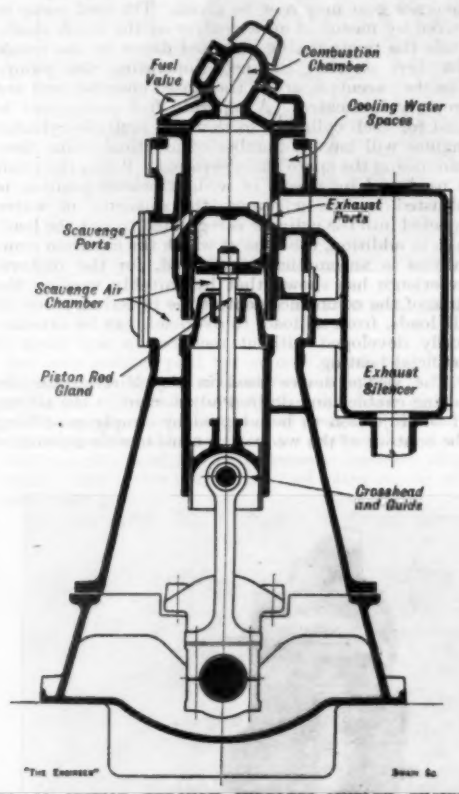


FIG. 13—SECTION THROUGH MIRRLEES-SIMPLEX ENGINE

Brief mention may be made of the two 3½ brake horse-power petrol paraffin engines exhibited on the stand. These engines also have interesting and original features of design, and we hope to refer to them in detail later. From what has been said it will be readily appreciated that the display of Mirrlees engines is in every way worthy of the leading position which the firm maintains among British oil engine builders.

North British Diesel Engine Works, Limited.

On the stand which is devoted to the various products of Swan, Hunter and Wigham Richardson, Limited, and its associated companies, there is to be seen a marine oil engine model of outstanding interest. We refer to the eighth-scale model of the new sliding cylinder double-acting two-cycle engine, which has recently undergone successful bench tests in the North British Diesel Engine Works at Whiteinch, Glasgow. This engine, which was designed under the Maclagan patents, embodies quite new features, and the design is one which not only goes to reduce size and weight, but which overcomes heat difficulties, and by adopting the two-stroke double-acting cycle reduces considerably the idle period of the engine parts. The first engine of this type was built in 1922 and consisted of a two-cylinder unit designed for an output of 240 brake horse-power and coupled direct to an electric generator. For some time this new engine was used as a lighting auxiliary on board ship and considerable running experience of a satisfactory nature was obtained. Last year the first large engine from which the model shown in Fig. 14 was made was constructed.

It is a three-cylinder unit designed to develop 2000 brake horse-power when running at a speed of 200 revolutions per minute. The cylinders are 24½in. bore with a piston stroke of 44in. In order to show more clearly the working principle the forward cylinder has been cut in section and the relative movement of the piston and the cylinder cover is shown. The model is so arranged that it can be rotated slowly by an electric motor of ¼ horse-power. Elsewhere in to-day's issue we give sectional drawings of the original engine and also a general view of the engine on the test bed. The engine now approaching completion will be shortly installed in a single-screw ship, the Swanley, built for Harris and Dixon, Limited, London, by Barclay, Curle and Co., Limited, Glasgow. The vessel is of the shelter-deck cargo type with the following dimensions:—Length, 410ft.; breadth, 55ft. 3in.; draught, 25ft. 4in. Her displacement at load draught is 12,560 tons and she is designed for a sea speed of 10½ knots at this draught. In addition to the model we illustrate, another interesting model, that of the vessel Swanley, and various constructional parts of North British Diesel engines are shown on the stand.

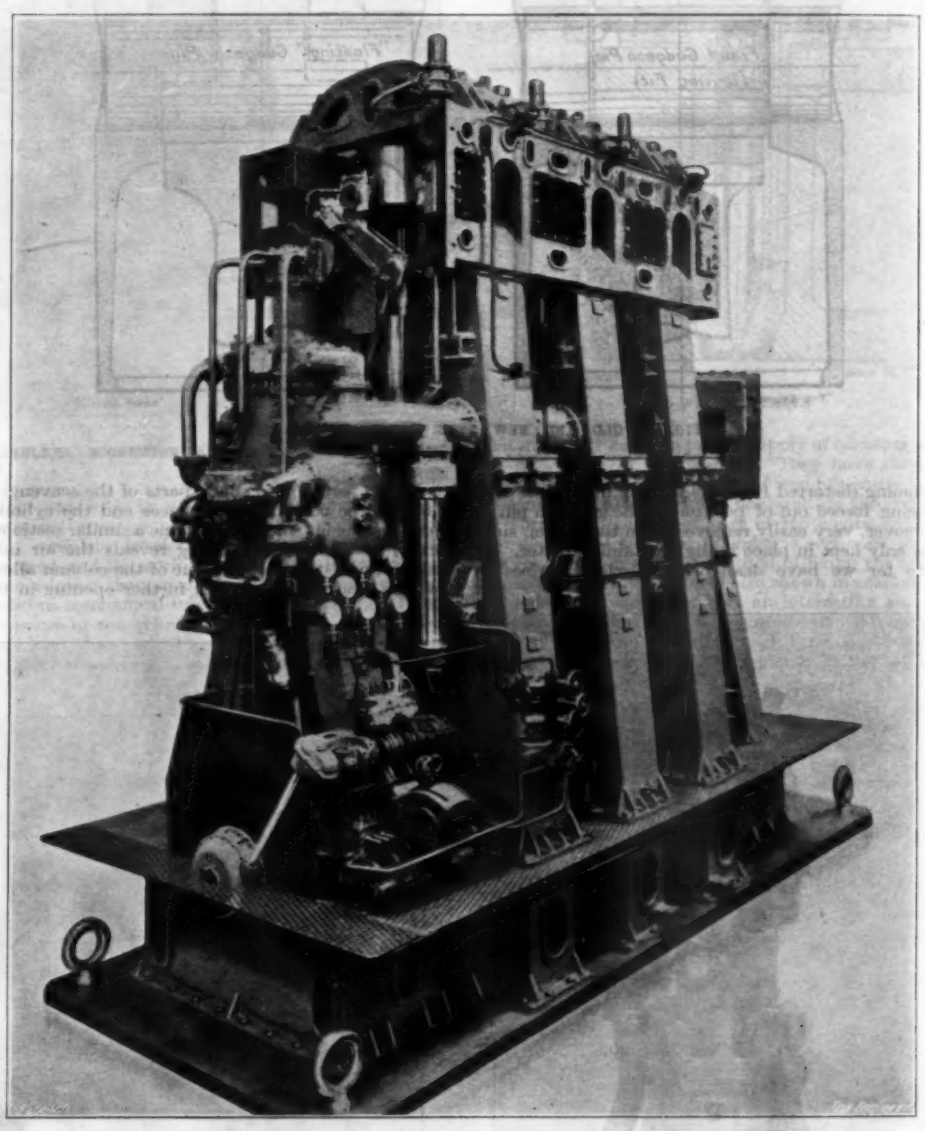


FIG. 14—MODEL OF SLIDING CYLINDER ENGINE—NORTH BRITISH DIESEL

Petters Limited, Yeovil.

The general design of the two-stroke oil engines manufactured by Petters Limited have been dealt with so exhaustively in THE ENGINEER that it is unnecessary to enlarge upon them here, but one or two refinements recently introduced are noteworthy.

These innovations chiefly concern the "S" or surface ignition type of engine, of which there are a dozen on the stand, ranging from 6 up to 42 horse-power. There are also, however, a number of "M" type engines, with magneto ignition, in sizes from 1½ horse-power upwards.

The cold starter now fitted on the "S" type engines is a great advance on the old system of heating the bulb by means of a blow lamp, and comprises a paper tube about the size of an ordinary sporting cartridge. It is filled with a chemically prepared tinder and is slipped into a holder, which, in turn, is screwed into the vaporiser as soon as the tinder is lighted by means of an ordinary match. The heat developed is sufficient to start the first explosion, and is maintained for two or three minutes, when the vaporiser will have become sufficiently warm to keep the engine running.

For engines above 18 horse-power, having two cylinders, compressed air is used for starting, and is distributed to the cylinders by means of a rotary valve driven off the crank shaft by a chain. It is only necessary for the attendant to open an air cock to start the engine, and there is no fear of the pressure being exhausted before the engine gets under way.

The oiling system has been slightly altered, and is now supplied from a mechanical lubricator operated by the fluctuation of the pressure in the crank chamber. A small cylinder, communicating with the crank case, contains a piston, which, by means of a ratchet motion, drives the cam shaft of the lubricator pump. The whole mechanism is fitted inside the oil container and is consequently thoroughly lubricated. Oil is forced to the cylinder, and it is also injected into the gudgeon pin bearing, and to a banjo on the crank web. Oil from the banjo is driven by centrifugal force up a hole in the crank pin, and thus lubricates the connecting-rod big end. The main crank shaft bearings are ring oiled.

Yarrow and Co. (1922), Limited.

In an article published in THE ENGINEER of June 15th, 1923, we described the evolution of the Yarrow land type of water-tube boiler, and gave an account of the first large Yarrow water-tube boiler which was installed at the Dunston power station of the Newcastle-upon-Tyne Electric Light Company, Limited. The success of this boiler has resulted in a series of recent orders for boilers of a similar type, among which we may perhaps mention those recently completed at Brighton Corporation electricity works and at Gravesend power station; while another boiler installation was recently started up at Londonderry and a series of very large boilers are rapidly approaching completion at the Barking super-power station of the County of London Electric Supply Company,

Limited. Industrial firms have not been behind the electric lighting undertakings in the adoption of the Yarrow design of boiler, and several important

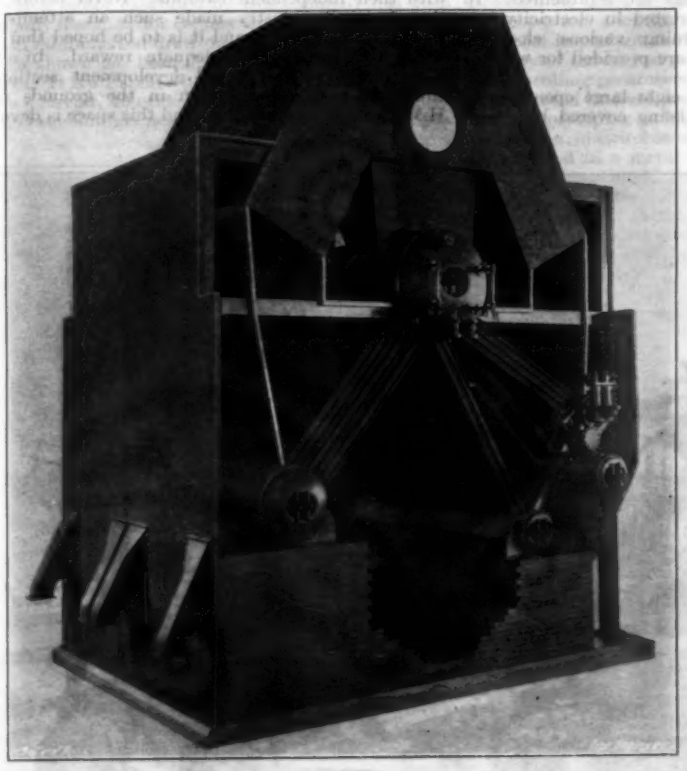


FIG. 15—LAND TYPE BOILER—YARROW AND CO.

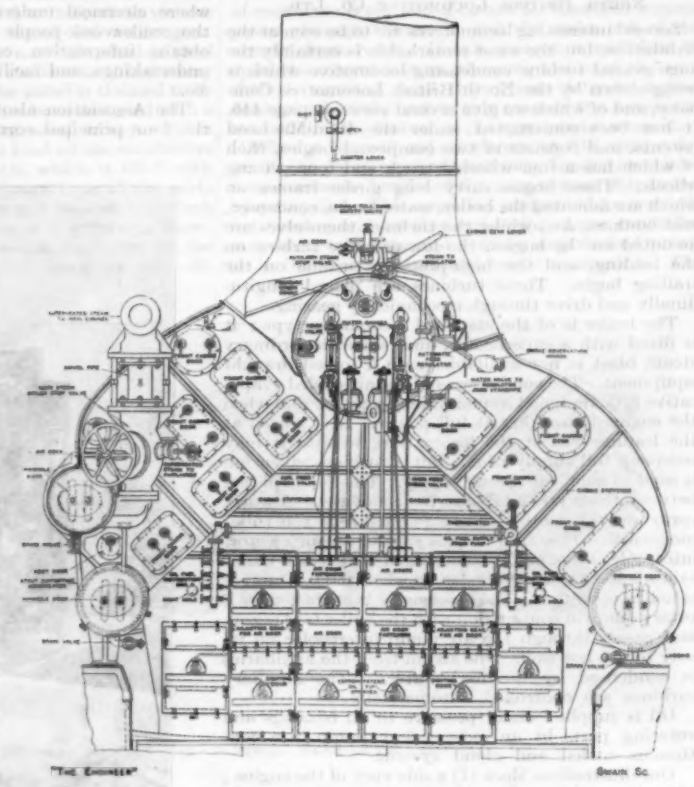


FIG. 16—MARINE TYPE BOILER—YARROW AND CO.

installations in Scotland, England and abroad are completed or already in hand. It may be stated in passing that Yarrow boilers are being made for a large Dutch power station by a firm in Holland which are licencees of Yarrow and Co., Limited. Taking these facts into consideration, it is fitting that Messrs. Yarrow's exhibit at Wembley should include a large-scale model of the Yarrow land boiler, a view of which we reproduce in Fig. 15. This model represents a boiler similar in design to those we have referred to, and it is constructed to a scale of one-third full size, and its height from the ground is over 14ft. Outstanding features are the Yarrow patented superheater and the patented air heater. It will be seen that the front casing of the boiler is removed so that the design and the construction of the different parts of the boiler may be more easily seen.

In the illustration, Fig. 16, a front view is given of the latest type of Yarrow marine boiler, adapted for oil fuel burning, which is shown in model form. The actual design is for a boiler capable of generating steam for a 12,000 shaft horse-power turbine installation. The drawing we reproduce shows in detail the doors and controls for the oil-burning gear. An exhibit of historical interest is the original Yarrow boiler, which was built in 1887, and on which the larger portion of the early experimental work was carried out. It is noteworthy that already up to the present year Yarrow boilers, representing over 25,000,000 horse-power, have been built or are now in course of construction.

Among many models which are shown on Messrs. Yarrow's stand we may perhaps single out for mention two of outstanding interest, which are shown in the two remaining illustrations, Figs. 17 and 18. One of them is a representation of the series of river gunboats which took such an active part in the operations in Mesopotamia during the recent war. The boat illustrated is 250ft. long with a breadth of 36ft. Altogether, twelve gunboats of this class were built and also sixteen of a smaller type, which were designed and constructed by Yarrow and Co.; the larger boats were designed by the firm and were built under supervision. Although the illustration shows a gunboat, the type is equally applicable for cargo or passenger steamer work. The other illustration represents the H.M.S. Tyrian, which has the reputation of being the fastest destroyer in the world. It was designed and built at Scotstoun and attained the remarkable speed of 40 knots.

Among other models we noted one of the Cutty Spark, a high-speed turbine-driven yacht having torpedo boat destroyer lines, which was specially built to the order of Mr. Henry Keswick, of Dumfries. Steam is supplied to the turbines of this yacht by two oil-fired Yarrow boilers, and the machinery is designed to maintain a sea speed of 21 knots. The Cutty Spark is well appointed, and has already made several long voyages, including a world trip. The firm also shows a Yarrow-type motor yacht, 129ft. long by 20ft. beam, which is designed for propulsion by either steam or internal combustion engines. Another type of vessel which is illustrated by three models, is the well-known Yarrow-type shallow draught river steamer. One example shows a shallow-draught vessel 210ft. long with a 33ft. beam, and a draught of 5ft., which is propelled by screws working in tunnels. The tunnels are fitted with the Yarrow patented automatic flap. The vessel referred to is one of many supplied for use on various rivers in the East. On certain rivers it has been found that excellent results are obtained with a stern paddle wheel. This type of craft is illustrated by the models of the Mosquito and the Herald, river craft which, on account of their simplicity, lend themselves admirably to conditions where only unskilled or native labour is available. A model is also shown of a

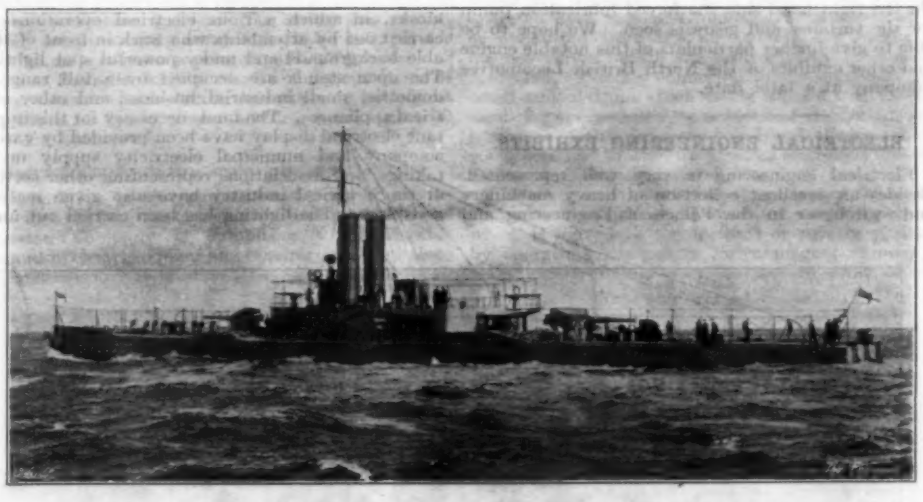


FIG. 17—SHALLOW DRAUGHT GUNBOAT—YARROW AND CO.

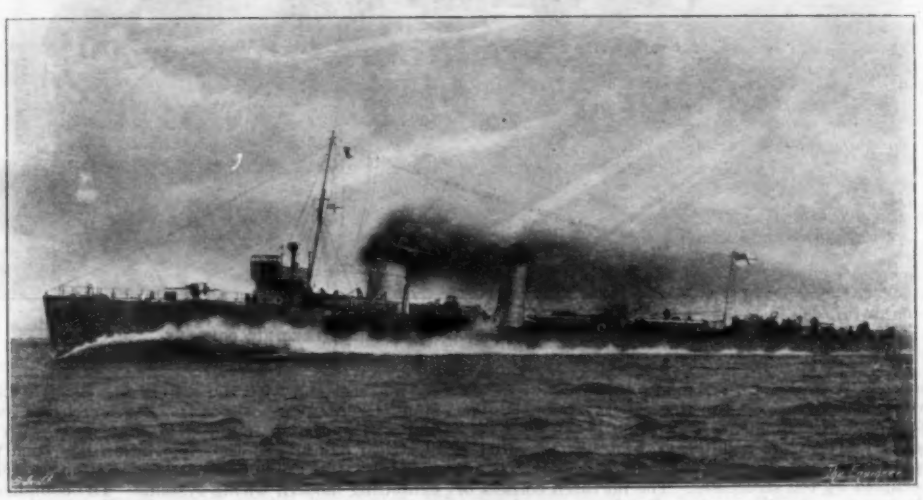


FIG. 18—H.M. DESTROYER TYRIAN—YARROW AND CO.

Yarrow-type shallow-draught steamer of 75ft. in length, of which a large number of similar ships have been built for use in different parts of the world.

North British Locomotive Co. Ltd.

Several interesting locomotives are to be seen at the Exhibition, but the most remarkable is certainly the huge geared turbine condensing locomotive which is being shown by the North British Locomotive Company, and of which we give several views on page 446. It has been constructed under the Reid-MacLeod patents, and consists of two compound bogies, each of which has a four-wheeled truck and four driving wheels. These bogies carry long girder frames on which are mounted the boiler, water tanks, condenser, coal bunkers, &c., whilst the turbines themselves are mounted on the bogies, the low-pressure turbine on the leading, and the high-pressure turbine on the trailing bogie. These turbines are placed longitudinally and drive through mechanically gearing.

The boiler is of the standard locomotive type; it is fitted with a superheater, and, since the ordinary steam blast is not available, with a forced draught equipment. The condenser is of the air-cooled evaporative type designed to maintain a high vacuum when the engine is working at full power. It is placed at the leading end of the locomotive, so that it may receive a full supply of air, but a turbine-driven fan is used to augment the air supply. This fan is placed between the driver's cab and the condenser. A water spray provided by a rotary pump keeps the tubes moistened. The air pump is of the steam ejector, intercooler type, and is so arranged that it will maintain a vacuum in the condenser when the locomotive is not in operation. The condensate is extracted by a rotary pump in conjunction with the boiler feed pump, and passes through the air pump intercooler on its way to the hot well. The steam from the auxiliaries is condensed by the feed water. The auxiliary turbines are controlled automatically.

Oil is supplied under pressure to all bearings and rotating parts by an independent pump in a continuous cooled and cloud system.

Our illustrations show (1) a side view of the engine; (2) a diagonal view from the front or condenser end; (3) interior view of cab, driver's end, in the centre of which can be seen the condenser fan with its turbine; and (4) interior view of the cab, fireman's end, in which are seen, under the window, the lubrication and water spray arrangements for condenser auxiliaries, and in the centre the forced draught arrangement. On the right-hand side the forced lubrication pump for the turbines and gears is seen. We hope to be able to give further particulars of this notable engine and other exhibits of the North British Locomotive Company at a later date.

ELECTRICAL ENGINEERING EXHIBITS.

Electrical engineering is very well represented. Besides an excellent collection of heavy machinery and switchgear in the Palace of Engineering and power-house there are many domestic exhibits which should appeal to the general public. The Electrical Development Association is taking a very active part in the exhibition, and has acquired a space of no less than 10,000 square feet, which are occupied by ten structures. The northern corners of the two main buildings of the Exhibition are the first display points to be reached by the public using the principal entrances, and the Electrical Development Association occupies one of these corners, which is served by two entrances. At the north end of this section there is an artistically designed house at which visitors may inspect all the electrical domestic appliances that are now available, whilst at the south end of the section there is the bureau and rendezvous, where electrical undertakings are represented. In the rendezvous people interested in electricity can obtain information concerning various electrical undertakings, and facilities are provided for writing, &c.

The Association also has eight large open stands, the four principal corners being covered by raised kiosks, in which various electrical operations are carried out by attendants who work in front of suitable backgrounds and under powerful spot lighting. The open stands are occupied by a full range of domestic, small industrial, business, and other electrical appliances. The funds necessary for this important electrical display have been provided by various company and municipal electricity supply undertakings, and associations representing other sections of the electrical industry have also given material assistance. The lighting has been carried out under the auspices and with the help of the Electric Lamp Manufacturers' Association. The extensive cable and wiring system required in connection with the electrical exhibits of the Association has been provided by the Cable Makers' Association, which is exhibiting modern wiring systems. The complicated tasks of carrying out all the work to the requirements of the Electric Supply Committee in control of the section was undertaken by the Electrical Contractors' Association, whilst the apparatus needed, which represents many thousands of pounds, has been placed at the disposal of the Committee for the period of the exhibition by members of the British Electrical Manufacturers' Association, who, of course, have also been put to heavy expense in connection with their independent exhibits. Never before has the electrical industry made such an attempt to popularise electricity, and it is to be hoped that the effort will meet with adequate reward. In addition to the main electrical development section a small space has been taken in the grounds near H.M. Government building, and this space is devoted to a display of electrical farm appliances and machines and appliances for general agricultural work.

FIG. 20—ELECTRICALLY DRIVEN CONVEYOR—GENERAL ELECTRIC COMPANY

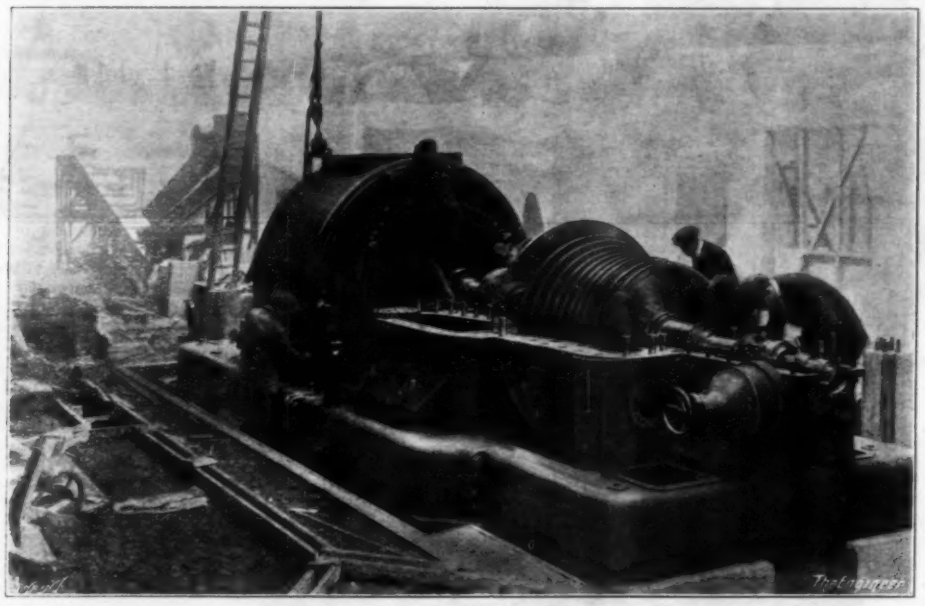


FIG. 19—5000 K.W. TURBO-ALTERNATOR—GENERAL ELECTRIC COMPANY

General Electric Company, Limited.

The section of the General Electric Company's stand which is devoted to heavy engineering displays plant and apparatus relating to generation, transmission, and the application of electricity. Heavy electrical engineering is also represented by conveyor plant—see Fig. 20—and a model electric winding engine, which serves to illustrate the work carried out at the Fraser and Chalmers' works of the General Electric Company. Perhaps the most important exhibit is the 5000-kilowatt turbo-alternator set shown in Fig. 19. For obvious reasons this set cannot be shown in actual operation, but it is to be seen slowly revolving, a section of the casing being removed in order that visitors may see the wheels and blading. The turbine is a Fraser and Chalmers' high-pressure machine designed to run at a speed of 3000 revolutions per minute. Two step-down transformers and a rotary converter are to be used in conjunction with this set, the largest transformer having an output of 550 kilovolt-ampères, the voltage on the high-tension side being 3000 and that on the low-tension side 340. The other transformer is designed for an output of 100 kilovolt-ampères and is intended to work on a 440/220-volt network. Both these transformers are of the General Electric Company's core type, the windings being immersed in oil and self cooled. The rotary converter, which is rated at 500 kilowatts and a pressure of 440/500 volts, runs at a speed of 1000 revolutions per minute, the voltage being controlled by reactances. A self-synchronising panel enables this machine to be started up in a very simple manner, only three operations being necessary on the part of the attendant.

Power-house switchgear is represented on this stand by a three-panel truck type switchboard which controls the three-phase incoming supply from the Exhibition at a pressure of 3300 volts, the high-tension side of the 550-kilovolt-ampère rotary converter transformer, and the high-tension side of the 100 kilovolt-ampère transformer. The low-tension side of this transformer is provided with tappings to supply the 440/220-volt power and lighting circuits. There is also a direct-current slate flat-back switchboard for controlling the incoming 440/220-volt supply, the outgoing supply to the main distribution board, and the direct-current side of the 500-kilowatt rotary converter.

In addition, there is a 33,000-volt steel work feeder cubicle fitted with an oil circuit breaker with a maximum short circuit breaking capacity of 350,000 kilovolt-ampères. Other heavy engineering exhibits of the General Electric Company consist of a transmission line with the necessary control and protective apparatus and motor and control gear for industrial purposes. The transmission line is connected to a

45,000-volt outdoor type circuit breaker, which is of similar design to those which the company has supplied to the Victorian Railways. The protective gear associated with the line is constructed in accordance with the Isenthal patents. A 45 horse-power slip ring motor exhibited by this company has been specially designed for colliery work and is controlled by an oil-immersed draw-out mining pillar. Another motor shown has been designed for service in a steel works. It is a 75 horse-power live roll motor, designed for a 440-volt, 40-cycle supply, and it runs at a speed of 465 revolutions per minute. It is controlled by a

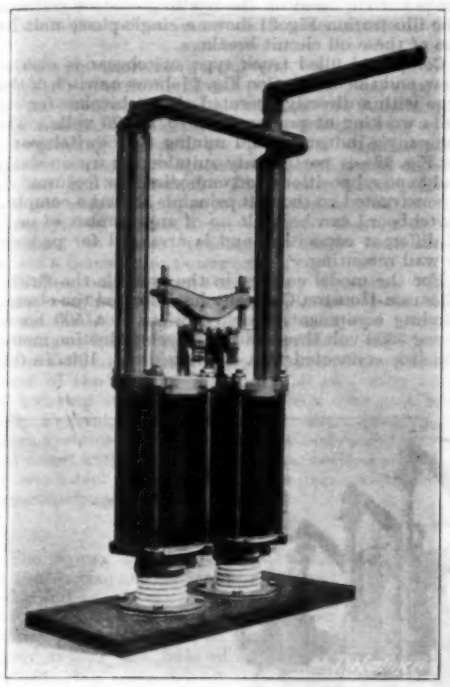


FIG. 21—OIL CIRCUIT BREAKER—B.T.H. CO.

starter of the contactor type with a reversing panel, operated by a separate master controller. The motor is totally enclosed in a stout cast steel frame which is designed so that the top half can be removed for inspection purposes. In order that rapid acceleration, retardation and reversal may be obtained the armature has been made small, and it therefore has small inertia.

There is also a ¾ horse-power textile loom motor which is wound for a 220-volt, 50-cycle supply, and designed to run at a speed of 720 revolutions per

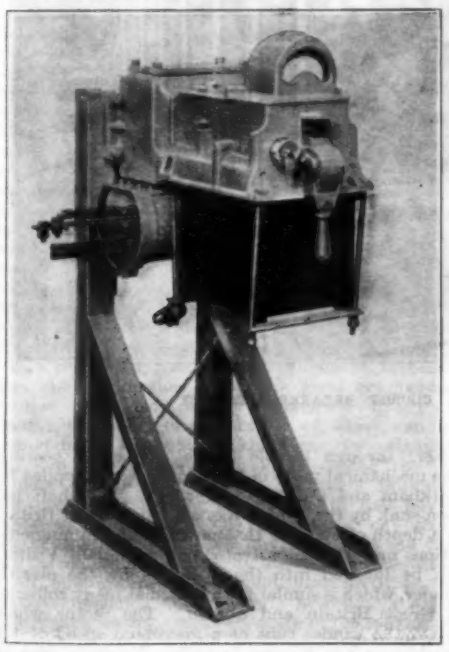


FIG. 22—SWITCHGEAR UNIT

minute. This motor, which is mounted on the end of a woollen loom, is of the totally enclosed type. For the control of this motor a special loom starting switch is provided. It is of the ironclad triple-pole quick-break pattern, the entire mechanism being enclosed in a steel case. Several motors of special and standard designs are also shown, including single-phase traction motors as built for the Brighton Railway. The hoist and magnet section of the General Electric Company's works is also represented. A lifting magnet 66in. in diameter, which is on view, is capable of raising a solid block of metal weighing about 20 tons.

A. Reyrolle and Co., Limited.

The exhibits of A. Reyrolle and Co., Limited, of Hebburn-on-Tyne, are designed to indicate to visitors the need for adopting the metal-clad switchgear. The most important exhibit is a switch panel as used in many of the largest power stations in this country for controlling generators. The panel is claimed to be the largest of its kind, and it has been designed with a view to providing a high degree of safety. As is well known, in switches of this kind all the conductors are enclosed in a metal sheath, which is filled with insulating compound. At the same time all the parts which may require inspection are accessible. Each panel is built up in the form of a complete three-phase unit with a separate metallic enclosure for the conductors. The main circuit breakers are oil-immersed, and they are contained in strong cylindrical tanks made of boiler plate. The incoming and outgoing conductors are connected through isolating switches, and owing to the provision of an interlocking system, it is impossible for anyone to gain access to any conductor that is carrying current. As the whole of the framework is earthed it is impossible for anyone to receive a shock. The switch has proved under actual working conditions to be suitable for continuous service at a pressure of 33,000 volts.

Other Reyrolle exhibits consist of various forms of power-house and sub-station switchgear and electrical apparatus for use in mines and for general industrial and domestic service.

British Thomson-Houston Company, Limited.

In addition to the power-house plant which we described a few weeks ago, the British Thomson-Houston Company is exhibiting a considerable amount of electrical plant and apparatus in the Palace of Engineering. It is impossible to do justice to all the company's exhibits in the space at our disposal, and we shall deal mainly with one or two of the traction exhibits and switchgear. The two examples of contactor control equipment shown in Figs. 23 and 24 are for the control of 1500-volt motors on multiple-unit trains. On each motor car there is a motor controller and a master controller. The former handles the current for the motors, whilst the latter merely governs the operation of the motor controller. This cam-operated motor controller gives a definite sequence of contactor operation and interlocks on the individual contactors are eliminated. Other advantages are that the electric control circuits are simple, the contactor arc chutes are assembled in a single group which swings downwards and exposes all the contactor parts, the contactors, reverser, relays, &c., are assembled in a single box, and the whole apparatus is light. Through the train wires a master controller directly operates the reverser, line breakers and the cam shaft, when closing the contactors of the first step, but the succeeding positions of the cam shaft and the closing of the contactors are controlled indirectly by the master controller through a current limit relay. As each section of resistance is cut out of circuit an increased current passes through the motor and the series coil of the current limit relay. If this current is sufficient to open the relay contacts, the progression of the cam shaft is arrested until the current falls to a predetermined value, and in this manner the automatic current-limiting feature of the apparatus is secured.

When a car will not accelerate at the current for which the notching or current relay is set, the motorman moves the handle of the master controller to the by-pass point. This operation is repeated for succeeding notches and by this means the motor controller may be notched up and held on any desired point, as in the case of a non-automatic equipment. The

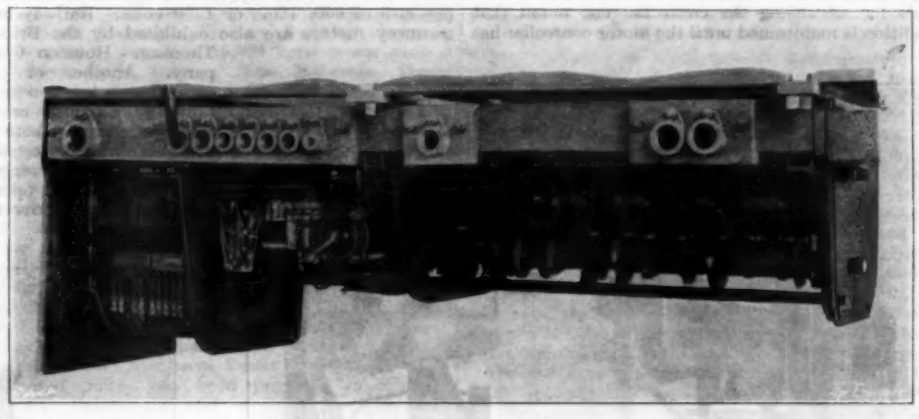


FIG. 23—1500-VOLT D.C. CONTROL GEAR—B.T.H. CO.

line breakers, reverser and contactors are actuated by air pressure controlled by magnet valves. The line breakers and reverser are provided with individual magnet valves and air cylinders, whilst a single-cylinder air engine with a double piston and two valves is used for the operation of all the contactors, which are actuated by cams mounted on a shaft, operated by a rack and pinion. Air is admitted to or exhausted from the air cylinder by means of magnet valves, which are controlled by the master controller. Directly connected to the cam shaft is a small control drum which makes contact with several small fingers mounted on a block of insulation, and by means of this drum the position of the cam shaft, corresponding to the train wires energised by the master controller, is determined.

The reverser compartment at one end of the motor controller contains an air-operated reversing drum, which is moved to the forward or reverse position by energising the proper valve magnet through a train wire, running from the reverse drum of the

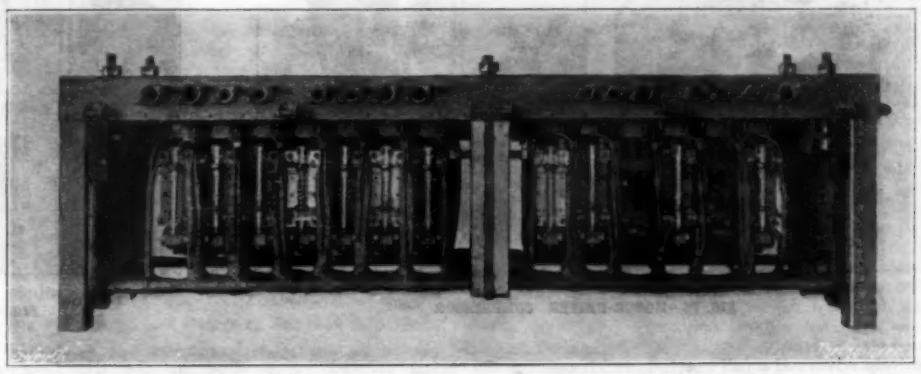


FIG. 24—SOLENOID-OPERATED CONTACTOR CONTROL GEAR—B.T.H. CO.

master controller. These valve magnet circuits are electrically interlocked with the line breakers, so that the drum cannot be moved unless the line breaker is open and the line breaker cannot be closed unless the drum is either in the full forward or reverse position. The line breaker consists of two contactors connected in parallel. Current for all the motors passes through these contactors and they open every time the master controller is brought to the "off" position. Each controller is closed independently against a heavy spring by means of an air cylinder controlled by a magnet valve. The reason for making the line breaker operate independently of the cam-operated contactors is to produce an additional link in the chain of protective drums, which are em bodied in this system of control. The line breakers open every time the master controller is turned to the "off" position, and the motor current is broken by the line breaker before the cam shaft has barely

started to turn. At times of overload, the breakers are opened automatically by the overload relay, and cannot be reset until the master controller is brought to the "off" position, and the overload relay is reset by the control and reset switch.

The air operating the pistons for closing the line breakers is controlled by solenoids which open and close air valves, a small push button being provided on top of each valve for testing the closing of the line breakers without control current or main current. If the air pressure, control current, or both fail, the line breakers immediately open. The current limiting or notching relay controls the rate of the automatic notching of the motor controller, and it has three shunt coils, which are known as lifting, holding, and by-pass coils. If the current rises too rapidly the control circuit is opened and the notching operating ceases until the current drops to a predetermined value. The relay is designed to work in conjunction with the rotation of the motor controller cam shaft and control drum, so that when the circuits have been made for advancing the controller one notch that condition is maintained until the motor controller has definitely advanced a full notch, notwithstanding the fact that the increase of current through the motors may operate the series coil of the relay and so prevent further subsequent advance of the controller. The rotation of the controller drum, which is directly connected to the cam shaft, alters the connections notch by notch, so that the necessary circuits are established to permit the controller to advance another notch if the values of current permit this being safely accomplished.

If, however, the conditions necessitate notching up the controller at a current value higher than that predetermined for normal automatic acceleration, the master controller handle may be moved to the by-pass position. This movement has the effect of neutralising the effort of the series coil to open the control advance circuit, so that the controller may be deliberately notched up in spite of the fact that the series coil may have been endeavouring to prevent further notching, but more than one notch may be obtained for one movement of the controller handle on to the by-pass position. If the controller handle be moved from the by-pass position and is then moved on to it, another definite advance of the controller may be made, and so on. This by-pass point on the master controller is useful for testing out the action of the controller notch by notch when the current supply to the motor circuits is off. The overload relay has an inverse time characteristic and consists principally of a main circuit series coil with its tripping and interlocking mechanism, together with a shunt re-set coil. The air gap can be accurately adjusted to ensure the immediate tripping of the line breakers when the current exceeds the safe predetermined value.

The air for operating the contactors, as well as for braking, sanding, whistling, &c., is obtained from a B.T.H. motor-driven centre-gear air compressor, as shown in Fig. 26. The cylinders, crank chamber, and all the bearings are in one casting. Positive and permanent alignment of all parts is assured, and vibration and noise are reduced to a minimum owing to the gear wheel being mounted on the centre of the crank shaft, between the cranks. The control equipments described are supplied for operation on a line pressure of 600, 1200, or 1500 volts. Railway and tramway motors are also exhibited by the British Thomson - Houston Company. Another of the company's traction exhibits is a trolley omnibus equipment. There is also an automatic sub-station, which is arranged for fully automatic operation, the rotary converter being started by a drop in the direct-current voltage due to increased load. The equipment includes a 500-kilowatt, 550-volt, compound wound rotary converter provided with end-play and over-speed devices, and it operates from the 3300-volt, three-phase, 50-cycle supply. The company's high and low-tension switchgear and two automatic re-closing direct-current feeders are associated with this exhibit.

Switchgear exhibits occupy a large section of the stand and demonstrate the very great progress which has been made in design during recent years. In addition to a 110,000-volt oil circuit breaker there are other oil circuit breakers designed for a wide range of voltages and rupturing capacities and to meet the varied requirements existing under practical operating conditions. The illustration Fig. 27 shows a breaker similar to many which have been installed in large power-houses and important sub-stations, and it is designed for 15,000-volt service. Two 10in. diameter seamless steel oil vessels or "explosion pots" lined with insulating material are provided on each phase, so that each of the two breaks takes place in a separate vessel. The moving contact bridge is of the inverted U type and consists of a pair of 1in. drawn brass rods for breaking the arc and a pair of laminated brush or V type contacts for carrying the main current. The brush contacts break before and make after the arc contact rods and are so designed that they give a wiping action on the cover of the oil vessels. The initial make and final break take place between the tapered ends of the rods, and bell-mouthed sockets formed of segments which are held together by springs in the bottom of the oil vessels. By this means even contact pressure is obtained, and compensation is made for wear on rods and contacts. Further, the arc is not ruptured on the working contact surfaces. The illustration Fig. 21 shows a single-phase unit for one of these oil circuit breakers.

Compound filled truck type switchgear is also on view, and the illustration Fig. 25 shows a switch of this type with a directly operated circuit breaker for circuits working at pressures up to 11,000 volts. The company's industrial and mining type switchgear—see Fig. 22—is particularly suitable for use in damp and exposed positions and embodies new features. It is constructed on the unit principle so that a complete switchboard can be built up of any number of units of different capacities, and is arranged for pedestal or wall mounting.

For the model colliery in the grounds the British Thomson-Houston Company has supplied the electric winding equipment, which consists of a 500 horse-power 3300-volt three-phase 50-cycle induction motor, which is connected to a winding drum, 10ft. in diameter, through double helical reduction gearing. The mechanical parts of the winder were supplied by Markham and Co., of Chesterfield. The shaft has been sunk by the Mining Association of Great Britain to a depth of 30ft., so that underground mining conditions may be demonstrated to the public. Visitors can be lowered into the workings by the electric winder, which is similar to that used at many collieries in Great Britain and abroad. The motor which drives the winder runs at a maximum speed of 470 revolutions per minute in either direction, and to bring about the rapid acceleration, deceleration and reversal, the British Thomson-Houston Company's switchgear has been designed on somewhat special lines. The stator connections are made and reversed by means of special high-tension air-break contactor gear, and mechanical and electrical interlocks are provided between the two sections of the gear, so that it is impossible for one to close before the complete rupture of the arc at the tips of the other.

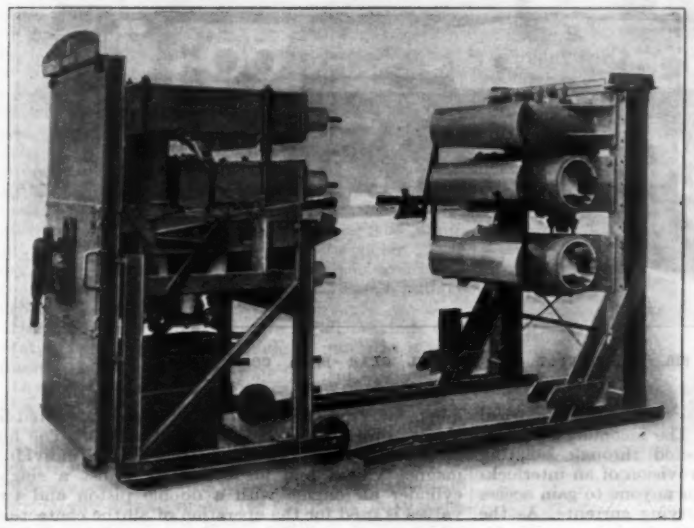


FIG. 25—TRUCK TYPE SWITCHGEAR

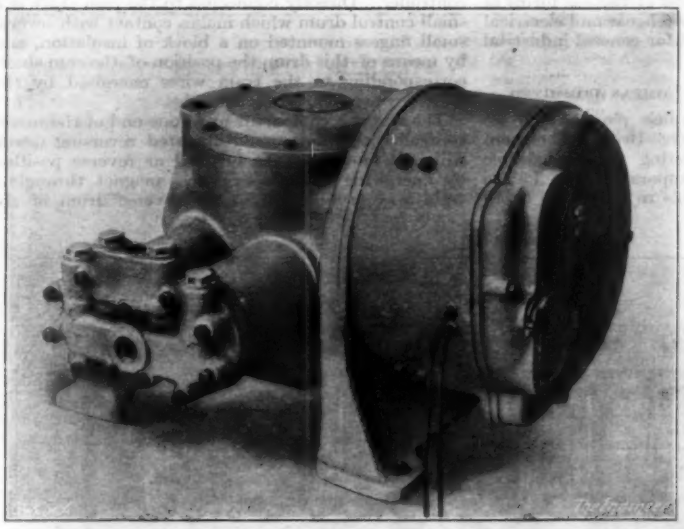


FIG. 26—MOTOR-DRIVEN COMPRESSOR

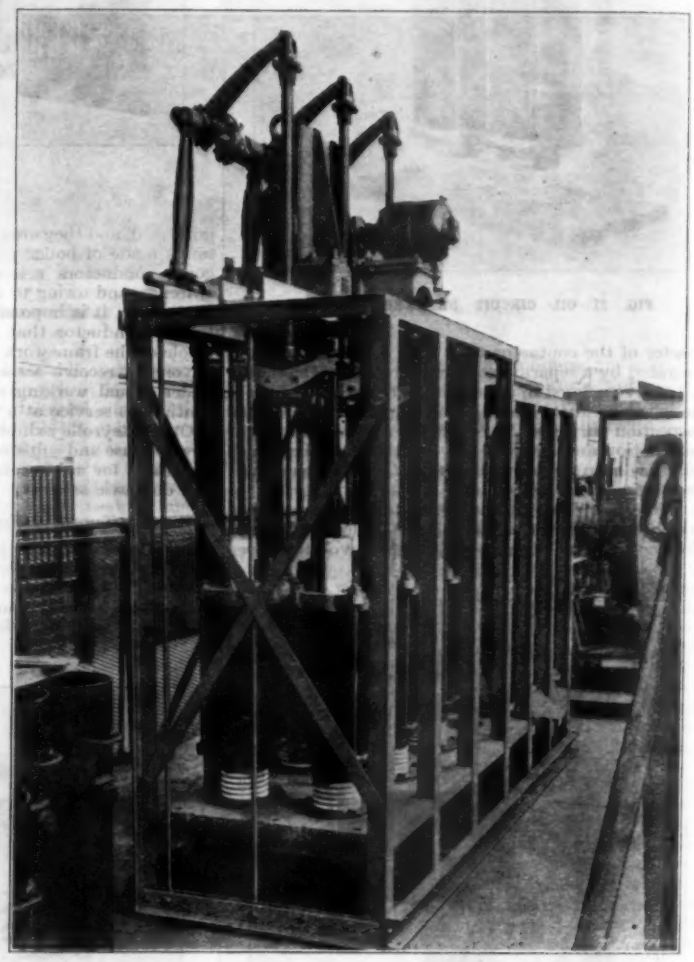


FIG. 27—OIL CIRCUIT BREAKER—B.T.H. CO.

Water Power Resources of Canada.

THERE has recently been completed in the Dominion Water Power Branch of the Department of the Interior, Ottawa, an interesting analysis of the water power resources of Canada, developed and undeveloped, as at February 1st, 1924. It includes special sections dealing with current progress in development, utilisation of developed water power and on the use of water power in the pulp and paper and central electric station industries, together with much other data of general interest. We append below a general summary of the document.

With an increase during the year 1923 of over a quarter of a million horse-power the total capacity of the hydro-electric installation of Canada has now reached a total of 3,227,414 horse-power, while the growing demand for power is demonstrated by the numerous large developments being rapidly pushed to completion. These new developments are not confined to any particular section of the country, but extend from coast to coast, and are designed to serve practically every community where a demand for power exists.

While complete data regarding Canada's water power resources are not yet available a great mass of reasonably accurate, as well as a considerable amount of specific data, are now filed in the records of the Dominion Water Power Branch of the Department of the Interior. During the past four years all existing stream flow and power data available from Federal, Provincial and private sources have been systematically collated, re-analysed and co-ordinated with a view to preparing revised estimates of available power based on uniform methods of computation and arrangement.

Basis of Computation.

The figures for undeveloped water power given in the accompanying table are based upon rapids, falls, and power sites, of which the actual existent fall or the head possible of concentration are definitely established or, at least, well authenticated. Many rapids and falls of greater or lesser power capacity are scattered on rivers and streams from coast to coast which are not as yet recorded, and which will only become available for tabulation as more detailed survey work is undertaken and completed. This is particularly true in the relatively unexplored northern districts. Nor is any consideration given to the power concentrations which are feasible on rivers and streams of gradual gradient, where economic heads may be created by the construction of power dams, excepting only at such points as definite studies have been carried out and the results made matters of record. In brief, the figures hereunder are based on definite rapids, falls and power sites, and may be said to represent the minimum water power possibilities of the Dominion.

The power estimates have been calculated on the basis of 24-hour power at 80 per cent. efficiency for conditions of "ordinary minimum flow" and "ordinary six months' flow." The "ordinary minimum flow" is based on the averages of the minimum flow for the lowest two consecutive seven-day periods in each year, over the period for which records are available. The ordinary "six months' flow" is based upon the continuous power indicated by the flow of the stream for six months in the year. The actual method used to determine this flow is to arrange the months of each year according to the day of the lowest flow in each. The lowest of the six high months is taken as the basic month. The average flow of the lowest seven consecutive days in this month determines the maximum for that year. The average of such maximum figures for all years in the period for which data are available is the estimated maximum used in the calculation.

This estimated maximum development is based upon the assumption that it is good commercial practice to develop wheel installation up to an amount, the continued operation of which can be assured during six months of the year, on the assumption that the deficiency in power during the remainder of the year can be profitably provided from storage or by the installation of fuel power plants as auxiliaries. The correctness or otherwise of this assumption for any particular site can only be definitely settled by careful consideration of all circumstances and conditions pertinent to its development. The method, however, enables a fairly satisfactory overall estimate of the maximum hydraulic power available as distinctive from the estimated ordinary minimum power available to be made.

Available and Developed Totals.

The known available water power in Canada, from all sources, and within the limitations outlined, is 18,255,000 horse-power, for conditions of ordinary minimum flow and 32,076,000 horse-power under a flow estimated for maximum development, *i.e.*, dependable for at least 6 months of the year. It is believed that these are conservative estimates, since an analysis of the water-power plants scattered from coast to coast, concerning which complete data are available as to turbine installation and satisfactory information as to stream flow, gives an average machine installation 30 per cent. greater than the six-month flow maximum power. Applying this, the figures quoted above, therefore, indicate that the present recorded water-power resources of the Dominion will permit of a turbine installation of 41,700,000 horse-power.

The total installation to date in water-wheels and turbines through the Dominion is 3,227,414 horse-power. In other words, the present turbine installation represents only 8 per cent. of the recorded water-power resources.

Current Progress.

In British Columbia the East Kootenay Power Company is constructing a 15,000 horse-power central electric station, the Granby Consolidated Mining, Smelting and Power Company and the Pacific Mills, Limited, have added 5000 horse-power and 6300 horse-power respectively to their present mining and pulp and paper installations, while the British Columbia Electric Railway Company is preparing to install a 25,000 horse-power unit in its Stave Falls Station. The Manitoba Power Company has installed two units of 28,000 horse-power each in its new power house at Great Falls, Manitoba, and expects to add a third similar unit this year. The City of Winnipeg also intends adding 3 units totalling 20,700 horse-power to its Point du Bois Station. The Hydro-Electric Power Commission of Ontario installed 130,600 horse-power during 1923, bringing its total installation to 746,029 horse-power, and expects to have an additional 147,000 horse-power in place before the end of 1924. Power for the mining district of Northern Ontario has been augmented by over 9000 horse-power, a 4000 horse-power development being completed by the Lower Sturgeon Power Company, and a similar station by the Great Northern Power Company, while additional power has been provided in existing stations. Before the end of 1924 an additional 45,000 horse-power is expected to be available from the Quinze River development of the Northern Canada Power Company and the Abitibi River development of the Hollinger Consolidated Gold Mines, Limited. In Quebec there were installed in various central stations some 30,000 horse-power during 1923, and construction work already under way provides for an additional 385,000 by the end of 1924, 280,000 horse-power of which will be in the great power stations of the Quebec Development Company on the Saguenay River and of the St. Maurice Power Company at La Gabelle. The year 1923 has seen substantial additions to existing central electric stations in the Maritime Provinces with further additions promised for 1924.

In summarising the above figures it may be pointed out that, while the total addition to Canada's hydraulic installation during the year 1923 amounted to 255,000 horse-power, there are at the present time actually in process of construction or in active prospect further hydraulic developments amounting to more than 900,000 horse-power.

Utilisation of Developed Water Power.

The 3,227,414 horse-power at present installed may be classified as follows:—

(*a*) 2,411,701 horse-power in central stations for general distribution for all purposes;

(*b*) 497,620 horse-power installed in pulp and paper mills, not including 228,755 horse-power purchased by pulp and paper companies from central stations; and

(*c*) 318,093 horse-power installed in industries other than central stations and pulp and paper mills.

The total installation for the Dominion averages 353 horse-power per thousand population, a figure which places Canada third in the per capita utilisation of water power among the countries of the world, Norway and Switzerland only having a higher per capita utilisation.

Water Power in the Central Station Industry.

Throughout the Dominion there are at present 282 hydro-electric central stations with an installed turbine capacity of 2,411,701 horse-power or a generator installation of 1,815,604 kV.A., of which totals 1,644,071 horse-power is installed in commercial or privately-owned stations, while 767,630 horse-power is installed in municipal or publicly-owned stations. The units vary in size from 10 horse-power to the 55,000 horse-power turbines recently installed in the Queenston development of the Ontario Hydro-Electric Power Commission. The turbine units in the industry average 3682 horse-power, while the average installation of the central stations is 8552 horse-power.

Water Power in the Pulp and Paper Industry.

Water power is operating 121 pulp and paper mills in Canada, 726,375 horse-power being employed. Of this total, 497,620 horse-power is actually installed in connection with the mills and 228,755 horse-power is purchased from hydro-electric central stations. The innovation of the electric drive is having marked and favourable influence on pulp and paper-manufacturing processes. It makes possible the centralised operation of fewer and larger mills receiving power from several power sites, together with the further advantage of uniform speed and better control in grinding, thus lessening costs of operation, construction and shipping. Of the 497,620 horse-power actually installed in pulp and paper mills 210,053 horse-power is used in the electric drive, besides which there is 228,755 horse-power of hydro-electric energy purchased from central stations, bringing the total horse-power employed in the electric drive up to 438,808.

Quebec and Ontario possess the largest natural pulp-wood areas in Canada, and they lead in pulp and paper production with 368,352 horse-power utilised in this industry in Quebec and 271,174 horse-power in Ontario; other producing provinces are British Columbia, 55,140 horse-power; New Brunswick, 14,378 horse-power; and Nova Scotia, 17,331 horse-power; total installation for pulp and paper mills, 726,375 horse-power.

Past and Future Growth in Utilisation of Water Power.

The growth of water-power developments in Canada has been striking. Total installed horse-power has grown from 975,000 to 3,227,000 since 1910, central station installation from 605,000 to 2,411,701 horse-power, and pulp and paper installation from 191,000 to 498,000 horse-power. Should the rate of installation since 1910 be maintained at its present rate there will be installed in 1925, 4,000,000 horse-power; in 1930, 5,000,000 horse-power; in 1935, 6,000,000 horse-power; and in 1940, 7,000,000 horse-power. These growth figures are considered conservative as the rate of growth since 1920 has been considerably in excess of the rate over the whole period from 1910. Available reserves are more than ample to take care of these future demands, as outlined, for a long time to come.

The water power now developed in Canada represents an investment of over 687,000,000 dollars. In 1940, should the rate of growth in installation during the past fifteen years be continued, this investment will have grown to over 1,500,000,000 dollars. The present development represents an annual equivalent of 29,000,000 tons of coal which, valued at 10 dollars per ton, represents 290,000,000 dollars. In the year 1940 these annual figures will, with the foregoing assumption, have become 63,000,000 tons and 630,000,000 dollars. These figures are striking evidence of the outstanding importance and necessity of an intelligent administrative policy governing the development of the Dominion's water-power resources.

Available and Developed Water Power in Canada.

Province.	Available 24-hour power at 80 per cent. efficiency.		Turbine installation: horse-power.
	At ordinary min. flow: horse-power.	At ordinary six months' flow: horse-power.	
1	2	3	4
British Columbia	1,931,142	5,103,460	355,517
Alberta	475,281	1,137,505	33,067
Saskatchewan	513,481	1,087,756	—
Manitoba	3,270,491	5,769,444	162,025
Ontario	4,950,300	6,808,190	1,445,480
Quebec	6,975,244	11,640,052	1,116,398
New Brunswick	50,400	120,807	44,539
Nova Scotia	20,731	128,204	54,950
Prince Edward Island ..	3,000	5,270	2,239
Yukon and North-West Territories	125,220	275,250	13,199
	18,255,316	32,075,908	3,227,414

The figures given in columns 2 and 3 in the above table represent 24-hour power and are based upon rapids, falls and power sites, of which the actual existent drop or the head possible of concentration is definitely known or at least well established. Many rapids and falls of greater or lesser power capacity are scattered on rivers and streams of gradual gradient, where economic heads may be created by the construction of power dams, excepting only at such points as definite studies have been carried out and the results made matters of record. The figures in column 4 represent the actual water wheels installed throughout the Dominion.

We may add that copies of the *Bulletin*, of which the foregoing is a summary, may be obtained, free of charge, on application to the High Commissioner for Canada, Kinnaird House, Pall Mall East, London.

A NEW Spanish decree provides for the grouping and ultimate nationalisation of the railways of Spain. The railways will be gradually nationalised according to a plan to be prepared by the Superior Council. Terms for buying out companies and for the remuneration of invested capital will be based on a net interest rate of 4½ per cent.

The Design of Works on Open Channels.

By F. V. ELSDEN, M. Inst. C.E., Executive Engineer, P.W.D., India.

Bernouilli's theorem has been described as the very foundation of hydraulics. It is very far from being a new theorem, being much older than any living engineers, is well known to all hydraulic engineers, and has numerous practical applications which, however, are almost always concerned with pipe lines.

That this should be the case in the British Isles, and, in fact, in the greater part of Europe, is, perhaps, natural, since the use of open channels for the conveyance of water is there relatively uncommon, so that the attention and ingenuity of engineers has there been directed mainly towards improvements in pipe lines and their appurtenances, though, perhaps, in future, the greater interest which is now being displayed in hydro-electric power installations may result in more attention being bestowed on open channels and the problems connected with them. In other countries open channels have been more commonly employed, but, except in Southern Europe and the United States of America, such countries are frequently somewhat backward countries wherein the most extensive application of open channels has been found in irrigation channels which are, for the most part, of such relatively modern origin that sufficient time has hardly elapsed for any great evolution in the design of works for open channels yet to have taken place.

It is, perhaps, due to these circumstances that the application of Bernouilli's theorem to problems of the design of works for open channels has remained in rather a backward state, and the possibilities, which the application of the theorem to open channel work present, have not, so far, received a great deal of attention. For though a good deal of work on the subject has been done of recent years in both the United States and India, examples of works, the design of which offends against the principle of Bernouilli, are more easy to find than are those which show a proper appreciation of its value. Text-books of hydraulics, as a rule, content themselves with a bare statement of the theorem with, perhaps, a few examples of its application to pipe work, but leave severely alone any question of its application to open channels, although some of the problems with which it is usual to deal in text-books would be more readily handled as applications of this theorem than in any other way.

It is true that Bernouilli's theorem can be ideally applied only to cases of steady flow, and steady flow in the laboratory sense of the term is very seldom met with in any practical hydraulic work. Fortunately, the more elastic methods of practical engineering do not call for any limitation of the use of the theorem to such ideal cases, and even though the flow is really turbulent the application of a practical coefficient will make it possible to employ the theorem usefully in cases in which velocities are employed that are far in excess of those at which, from a strict scientific point of view, turbulence has long ago set in.

That Bernouilli's theorem can be successfully applied even when flow is turbulent, is a fact which makes it possible to adopt, in certain classes of works on open channels, velocities much higher than have formerly been considered to be permissible, for it means that it is possible to convert velocity into a rise of level so that the loss of head which need be incurred in passing water through a constriction need be little more than the increased frictional loss which arises from the higher velocity, and this will, in general, be large only where the constriction is of considerable length. The head used in generating the higher velocity can, within limits, be almost entirely reconverted into a rise of level. Increased velocity makes possible a reduced waterway, so that the application of Bernouilli's theorem to reduce the cost of works on open channels becomes apparent.

Inverted Syphons.

It stands to reason that if head is to be saved while making use of high velocities, great care must be exercised in the design of the works concerned to avoid all preventable causes of turbulence, and it will be found, therefore, that very considerable alterations are called for in many old-established types of works. An example of this is to be found in the case of inverted syphons. It has been customary when designing such works to allow for a total loss of head through the work amounting often to more than $1.5\ v^2/2g$, where v is the mean velocity in the barrel of the syphon. That is to say, owing to defects of design, the whole of the velocity head was lost together with an allowance of $\frac{1}{2}\ v^2/2g$ for head lost at entry, and a further allowance for frictional losses in the barrel of the syphon.

Where conservation of head is of any importance, such large losses would evidently, if unavoidable, make it quite impossible to adopt a high velocity through the barrel of the syphon. Fortunately, it can be due only to bad design if losses of this magnitude are incurred, the large losses at entry to bad design of the entry to the barrel, and the destruction of velocity head to bad design of the exit from the barrel, and, perhaps, unnecessarily large frictional losses to avoidable roughness in the barrel itself. If the entry to and exit from the barrel are carefully designed, bends and abrupt changes of section being avoided, there is no reason why entry losses should not be reduced almost to zero, and the velocity head almost entirely recovered at the exit.

There are, of course, limits to the velocity which can be employed; care must be taken to avoid the formation of a standing wave at the exit, and there is likely to be an upward limit to the velocity which can be permitted in the barrel without causing excessive turbulence, but this probably exceeds, in most practical cases, 15ft. per second. In several cases within the writer's experience, wherein this velocity was exceeded, there has been definite, though incomplete, recovery of velocity head at the exits from syphons even though these exits were not intentionally designed to effect this, while in one case which he has seen, in which the exit had been carefully designed for the purpose, recovery was excellent, the rise of water surface as velocity was reduced taking place in a quiet, steady manner which was most striking.

Bridges and Bridge Piers.

Bridges and bridge piers are another class of work, the established types of design of which frequently cause needless loss of head, and this is the more remarkable because rivers call for such numerous works of this class. The importance of saving head in the design of river bridges is not at all times apparent; in fact, it is, as a rule, only during floods that any great importance attaches to economy of head in the passage of water through the waterway of the bridge. But at such times it may be a matter of very considerable importance to reduce to a minimum the obstruction caused by the bridge, for excessive loss of head in the passage of water beneath the bridge not only delays the subsidence of river floods by increasing the time required for the accumulated water to run off, but may also very seriously increase the area of land upstream of the bridge which is subject to inundation, a direct consequence of needless afflux and backwater. Instances are common of bridges at which the obstruction offered could be readily reduced without any increase in waterway, and of bridges of which the waterway is greater than it need have been had there been more attention to hydraulic detail in working out the design.

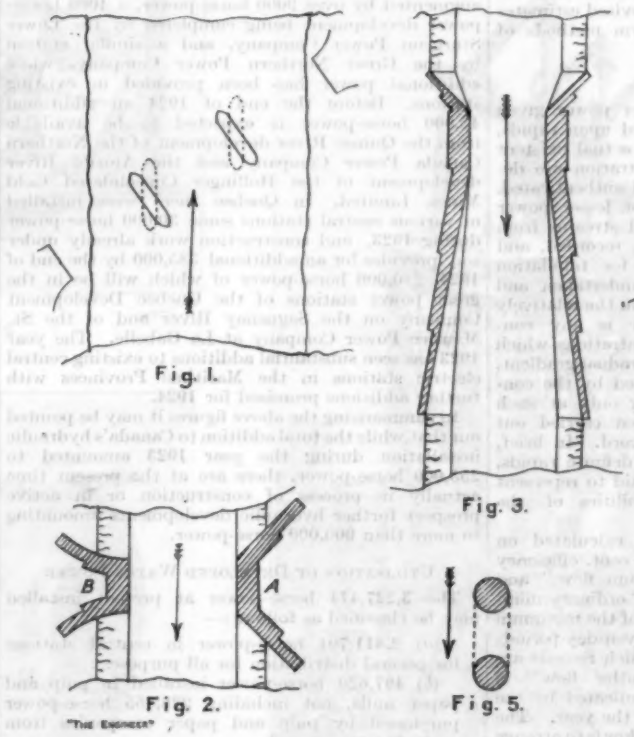
In bridge designs four principal errors occur which cause avoidable obstruction to flow. These are:—(1) Wrong alignment of piers; (2) incorrect shape of abutments; (3) wrong type of piers; (4) wrong shape of piers.

Alignment of Piers.

Error in the alignment of piers is really inexcusable, but is nevertheless not uncommon. In designing a road bridge over a railway or a railway bridge over a road, the designer would never think of aligning the piers in any direction but parallel to the lines of traffic under the bridge. But for some reason water seems often to be judged by a different standard, for in the not unusual circumstances of an oblique crossing of road or railway over a river it will often be found that the piers are aligned at right angles to the centre line of the road or railway, and are consequently set obliquely to the direction of flow of the current in the river, the position being as shown in firm lines in Fig. 1. This is an arrangement of which the writer has seen examples in quite modern bridges of considerable dimensions. Such mal-alignment of the piers is certainly a convenience for the purpose of constructing the bridge, since it avoids skew spans; but it would be difficult to imagine anything more open to objection on hydraulic grounds, for, in addition to causing needless obstruction of waterway and hence afflux and flooding upstream of the bridge in times of flood, the turbulence and obliquity of flow caused by the piers is likely to cause erosion of the river bank and bed downstream of the bridge. If such a bridge does not cause trouble in these respects it can only be because it has an unnecessarily large waterway which, were the piers correctly aligned in the direction of flow of the water, as shown by the broken lines in Fig. 1, could be considerably reduced, with a corresponding saving in the first cost of the bridge.

Shape of Abutments.

Incorrectly shaped abutments are an even more common but, as a rule, less serious fault in bridge design. Less serious because in bridges of some size the influence of the shape of the abutments on the flow through the bridge opening is relatively small. Abutments are commonly made of one of the shapes A or B in Fig. 2, and if the abutment is clear of the water these shapes are free from objection except on the grounds that this fact may itself be an indication that the waterway of the bridge is excessive. If water is in contact with the abutments the shape A is bad and the shape B worse, for the shape A forms a contraction having an insufficiently gradual entry and exit, while the shape B constitutes a sudden contraction followed by a sudden enlargement, so that both are likely to cause waste of head and afflux upstream of the bridge.



The best form hydraulically, and one which need cause no appreciable loss of head even though the waterway is considerably restricted, is that shown in Fig. 3. The wings here are nearly in continuation of the face line of the abutment, but they open out gradually both upstream and downstream. The river faces of the wings are warped, being vertical at the line of junction with the abutment, and merging gradually into the slope of the river bank. The length of the entry or upstream bell mouth may be fairly small, but the exit or downstream bell mouth must be made long with a very gradual taper in order to make sure of good head recovery. To reduce cost a portion only of the wings would be of masonry, until a fairly flat slope was attained, the remainder of the warped surface being of a cheaper form of revetment.

It is recognised that abutments of this form may not always be practicable, for they may prove to be even more costly than would be the provision of sufficient waterway to effect the same purpose, while wings constructed in this way would, of course, not serve as part of the abutment to take up some of the thrust of an arch. But this arrangement forms an alternative to a large waterway which will be worth considering when it is necessary to avoid afflux.

Navigable rivers are, of course, to be judged by a somewhat different criterion since the greatest velocities which can be permitted from consideration of navigation will often be too small to cause any risk of excessive afflux, whatever may be the shape of the abutments.

RECOVERY OF HEAD.

There has not been a great deal of experimental work done for the determination of the extent to which recovery of head, that is, conversion of velocity into a rise of level, can be effected in open channels by the careful graduation of the exit from a contraction. The only published work on the subject with which the writer is acquainted is contained in a paper by Mr. E. W. Lane, which was published in 1919 in Vol. XLV. of the "Transactions" of the American Society of Civil Engineers. In this paper will be found the results of a limited series of experiments on an expanding flume which show very fair recovery of head, though recovery is not as complete as might have been expected.

That this was the case seems likely to have been due partly to the entry to the contracted section having been too sharp, involving needless loss of head at entry, and partly to the rate of expansion of the exit flume having been too rapid, the expansion having been from 1ft. width to 3ft. width in a length of 7½ft. Pipe experiments have shown that the best results are obtained when the rate of expansion is two units of diameter in 20 units of length, corresponding to a subtended angle of about 5 deg., and if it may be assumed that the same will hold good for open channels, and this seems reasonable, then it is clear that in order to obtain the best results, the flume experimented on by Mr. Lane should have been increased in length from 7½ft. to 20ft. But it seems certain that other factors will also affect the question, one of the principal being probably the ratio of bed width to depth of the channel at the constriction. It is likely that the smaller this ratio the greater will be the advantage of a carefully designed expansion at the exit from a contracted section.

For a complete investigation of the subject not only should experiments be made on various rates of expansion and contraction in the exit and entry flumes, but these varying rates of expansion and contraction should be tested in combination with various ratios of bed width to depth. But even in the absence of any really complete series of experiments of this nature, there can be no doubt that the influence of the shape of the abutments will become less as the ratio of bed width to depth becomes larger, and it is likely to be of little importance for large span bridges over relatively shallow rivers.

The writer has been informed of a case of recovery of head by means of a gradual expansion in which it is claimed that not less than 1ft. of head was recovered in the forebay of a hydro-electric installation. At the end of the conduit, where it opened out into the forebay, the shape of the channel was somewhat as shown in firm lines in Fig. 4, forming an expansion of rather a sudden character. By the construction of an island of triangular shape, as shown by the broken lines, the rate of expansion was so reduced that the velocity was gradually checked and converted into a rise of level, and by the time the end of the island, which was termed a disperser, was reached, the velocity had been so far reduced that the loss of head resulting from the sudden expansion was negligible. Actually, almost the same result would have been obtained had the entry to the forebay been built in the first instance with a less rapid expansion, giving the same rate of increase of width as has been obtained by means of the disperser. This would have required a longer expanding channel, but would have had exactly the same effect in saving head, and would be exactly analogous to the exit from the contraction formed by the abutments of a single-span bridge.

TYPE OF PIERS.

The type of bridge pier which is adopted is less commonly open to objection, for they are, as a rule, of solid masonry; but instances occur of double piers, such as are shown in Fig. 8, in which the type of pier is decidedly open to objection from the hydraulic standpoint. Piers of this description cause a sudden contraction of section followed by a sudden expansion again immediately followed by a duplication of this set of conditions which very much accentuates the loss of head incurred in the passage of water beneath the bridge. Double piers of this description would be free from objection were the space between the two parts filled in on each side by means of a light partition, as indicated in broken lines in Fig. 5. The water between the piers would in this way be put out of action instead of forming head-destroying eddies. These partitions need have no strength except to withstand blows from floating *débris*, for pressure could be admitted to both sides of them through small orifices.

SHAPE OF CUTWATER.

The shape of bridge piers is a matter which does not seem to have been the subject of much investigation. The only examination of the subject which appears to have been published is to be found in a paper entitled "Obstruction of Bridge Piers to the Flow of Water," which was read before the American Society of Civil Engineers by Mr. Floyd A. Nagler in 1918—"Trans.," Am. Soc. C.E., Vol. XXXII.—in which are described experiments which were made on model bridge piers for the purpose of ascertaining the form of pier which would cause least afflux.

The traditional form of cutwater for bridge piers is a double segmental shape, as illustrated in Fig. 6, the shape of both upstream and downstream cutwaters being the same. Sometimes semi-circular cutwaters are employed, or they are occasionally made triangular, or even square. Mr. Nagler's experiments, which were on a small scale, led him to the conclusion that the best forms are those illustrated in Fig. 7—a semi-circular, or semi-elliptical cutwater, as at A in that figure, at the upstream end, and a streamlined shape, as at B, at the downstream end. He also came to the conclusion that the shape of the upstream cutwater has a much greater influence on the obstruction caused by the pier than has the shape of the downstream cutwater. Mr. Nagler's first conclusion—that the shapes shown in Fig. 7 are the best—is undoubtedly generally correct, though it is probable that the streamlined form B would be best for the upstream cutwaters also, were it not for the impossibility in practice of ensuring that the direction of flow of the streamlines shall be truly parallel to the centre line of the pier. It is evident that the slightest obliquity of flow would seriously reduce the efficiency of the form B were it made use of for an upstream cutwater, while, on the other hand, slight obliquity is not likely much to affect the efficiency of the shape A.

Mr. Nagler's second conclusion—that the shape of the upstream cutwaters is of more importance than is that of the downstream cutwaters—is less easy to understand when it is remembered that the efficiency of head recovery depends wholly on the downstream cutwaters, and the present writer is of the opinion that further experiments on a somewhat different scale would show it to be erroneous. The conclusion is in full accord with the results of Mr. Nagler's experiments, but the experiments themselves appear to have been inadequate thoroughly to test this point. The scale of the model was too

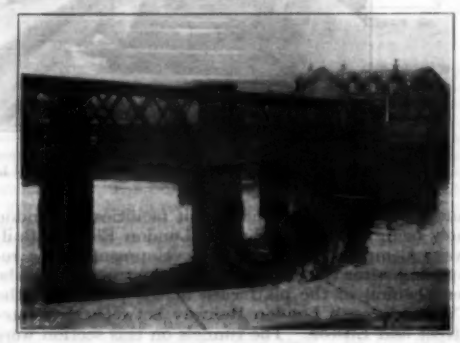


FIG. 8

small and the dimensions not relatively suitable, while the length of the downstream cutwaters used in the experiments was far too short for it to be possible to effect really satisfactory recovery of head at the downstream end.

The principal dimensions of the model pier of this form which was tested were as shown in Fig. 7, giving the downstream cutwater an average convergence of 1 in 4. Had the length been increased to 48in., giving an average convergence of the sides of the cutwater of 1 in 16, it is probable that very much greater efficiency would have been obtained and the downstream end would have been found to have more influence than the upstream end. That longer tail cutwaters were not tested was evidently due to their not being shapes which it is practicable to construct, for Mr. Nagler's purpose was to ascertain the best practical form, and even the short streamlined shape B in Fig. 7 he rules out as not being practicable, substituting, as the next best, a triangular or a semi-circular shape. This is certainly a great difficulty, for a long cutwater, tapering gradually to a very fine point, would be almost impossible to build, and even if built would be very liable to damage from blows from floating bodies.

The present writer has had occasion to consider whether a type of cutwater cannot be found which shall be practicable to build, and shall at the same time so far approximate in its effect to that of a thinly tapered cutwater that good recovery of head shall be obtained by its use, and he has arrived at a design which he believes will effect this purpose, but as no suitable opportunity has yet occurred for making a practical test of this design, a description of it would at present be out of place.

A CASE OF EROSION.

While dealing with the subject of bridge piers, reference may be made to a case within the writer's experience of a multiple-span bridge over a canal, which had a flooring of dry brickwork in the canal bed beneath the bridge, and extending to some little distance upstream and downstream of the bridge, for the purpose of protecting the canal bed from erosion. The velocity of the water under the bridge was fairly high, some 6ft. per second, and after a time this dry brick flooring showed serious subsidence on the downstream side of the bridge, opposite the downstream cutwaters. The only explanation which could be found for this subsidence was that it was due to erosion of the material beneath the dry brick flooring, arising from the eddies which were set up in the sheltered water opposite the downstream ends of the piers by reason of the cutwaters being too blunt, for the portions of the flooring which lay between the bridge piers and downstream of the bridge opposite the open bridge spans, although exposed to the full force of the current, showed no signs of damage, nor was there any damage to the flooring on the upstream side of the bridge.

This is a most interesting example, and one which points to another advantage that results from careful design of the entries to and exits from contractions in open channels, in addition to the economy of head which is obtained. It is powerful eddies rather than high velocity of flow which are the cause of erosion in streams, so that works which cause great loss of head—which is synonymous with causing powerful eddies—must necessarily be more likely to cause erosion than are more scientifically designed works, even though the latter make use of much higher forward velocities. Where there is small loss of head, there is evidently less energy available for the destruction of the bed and banks of the channel. When, on the other hand, a work causes great loss of head, although there is a large drop in water surface level, and apparent destruction of energy, the energy which that drop represents remains at work for a considerable distance downstream in the form of useless and destructive eddies which attack the bed and sides of the channel. It follows that a work which is not economical of head will require very much heavier protective measures on its downstream side than will one in which precautions are taken by careful design to prevent the formation of eddies and the loss of head, so that care in design not only maintains the water at a higher level, but also reduces the cost of the protective works which are necessary, and the liability to damage and heavy expense in repairs.

There are, of course, some classes of works, common on irrigation canals, the very object of which is to destroy head in order to accommodate the water surface level to a steeply sloping ground surface. At such works, precautions against the formation of eddies would naturally be out of place, and for them the attention of the engineer must be directed to the location of the eddies in places where they can do little damage, and not to their suppression; unless, indeed, the circumstances are such that the surplus energy can otherwise be usefully employed—in driving machinery, for instance.

WEIRS.

Weirs next fall to be considered, and are a class of work which has been much investigated, and is therefore better understood than are horizontal contractions of waterway. They may be placed in two classes, according to the purpose which they are intended to serve. One class, used principally on artificial channels having only a small range of discharge, is intended merely to maintain a certain minimum water level upstream of the weir, and so to destroy head that water is delivered at a certain lower level downstream. Such weirs are devices for the destruction of head, and call for no further mention here. The other class, almost universal on natural channels and used also on artificial channels, is required to maintain in a stream of considerable range of discharge a fixed minimum upstream water level during low-water periods and the lowest possible maximum water level during high-water periods. The minimum upstream low-water level will, except in cases of weirs with movable crests, often coincide with the level of the weir crest, so that the design of this class of weir really becomes a question of finding the shape of weir crest which has the greatest coefficient of discharge.

This is a subject which has been closely investigated experimentally, particularly in the United States, where a coefficient as high as 3.8 in the standard broad-crested weir formula $Q = C L H^{\frac{3}{2}}$ has been obtained with some shapes of crest. The results of these experiments are given in at least one modern text-book—"Hydraulics," King and Wisler (Chapman and Hall, 1922). For the design of spillways for dams or of any weir which holds up water considerably without the aid of a movable crest this is all that is needed, for no question of economy of head arises in such cases. But low weirs are in some circumstances necessary where the weir is required to discharge submerged with a fixed minimum tail water level, and at the same time with the least possible fall in water level over the weir. In such cases Bernouilli's theorem again comes into play, and it becomes necessary to design the weir so as to effect the conversion of the high velocity over the weir into a rise of water surface level below the weir.

The orthodox method of calculating the discharge over a submerged weir is to treat the portion which is above tail water level as a free fall, and the portion which is below it as a submerged orifice, but it has been found experimentally in India—"Observations

of Discharges over Weirs," F. H. Burkitt, "Proceedings," Punjab Engineering Congress, 1919—that this is not correct in those cases to which the broad-crested weir formula $Q = C L H^{\frac{3}{2}}$ is applicable. In such cases it is found that the discharge is independent of the tail water level through a considerable range, at any rate up to a ratio of submergence—that is, of depth of tail water over crest to depth of water upstream over crest—of rather more than 0.6, while, where special care was exercised in design, the discharge was unaffected by submersion up to a value of this ratio exceeding even 0.8.

Moreover, it was found that the point at which the discharge over the weir ceased to be independent of the tail water level was very definitely shown by the behaviour of the water, independence of the tail water level being marked by the presence of a frothy standing wave downstream of the weir. When this frothy standing wave was replaced by a smooth undulation the discharge began to be affected by the tail water level. These results have been independently confirmed by another observer in India, and may be taken as well established. The frothy standing wave is, of course, an indication that head is being wasted and dissipated in the eddies formed in the wave; but when this wave is replaced by a smooth undulation it is evident that there is little or no waste of head, and that the high velocity over the weir is being converted into a rise of level downstream of the weir. In favourable cases there will be little appreciable difference of level between a point immediately downstream of the undulation below the weir and a point somewhat upstream of the crest of the weir, a smooth trough in the water surface forming the only indication of the presence of the weir.

During the course of the experiments above referred to, it was further found that if the weir were correctly shaped it was possible to build a weir not exceeding a certain definite height for every depth of water, such that at that particular depth of water or greater depths there was no appreciable loss of head in passing over it. This is merely another instance of the way in which Bernouilli's theorem can be made use of in practice on open channels. A weir is a contraction of the section of the stream which calls for an increase of velocity, but if that contraction is correctly designed the coefficient of discharge of the entry to the contraction becomes almost unity, and the increased velocity is almost completely reconverted into a rise of water surface level downstream of the weir. There will be a drop of surface level as the weir crest is approached which reaches its maximum at the crest of the weir and is followed by a gradual rise of water surface level downstream of the weir as the velocity is gradually checked and converted into a rise of level.

This last result is one which is capable of most useful application, for within limits it permits of low water being held up by means of a fixed weir which shall cause no increase in the upstream water surface level during floods. Even though the maximum permissible height of weir is less than is required to hold up the water to the required height during periods of low water, it will make possible considerable saving in the cost of a movable crest for the weir, for the height of the movable portion can evidently be reduced by an amount equal to the height of the weir which will cause no afflux during floods.

Conclusion.

The present article makes no claim to be at all complete in its treatment of the subject of the conservation of head in open channels. Hydraulic works of many descriptions are equally susceptible of improvement in this respect on the same lines as have here been suggested for a few types of work. Water may be led, but cannot be driven, and in designing works for the passage of water attempts to force it to behave in an unnatural manner are almost invariably found to result in waste of some sort, arising either from needlessly high cost of construction or from high maintenance costs due to the insidious action of eddies, the presence of which is perhaps hardly suspected. Many considerations other than hydraulic excellence must, of course, always enter into the design of works connected with water, and the design finally chosen will frequently be a compromise between conflicting interests, but the writer believes that there are numerous instances in which more attention to the laws of hydraulics would result in a more satisfactory design or a cheaper structure of equal efficiency, or in both.

The Camden Town Tube Extension.

Sunday last, the 20th instant, saw the completion of another stage in the programme of extensions of and improvements in the transit facilities of London now being carried out by the London Electric Railways Company. The latest development is the re-opening, after the enlargement of the tunnels and the lengthening of the platforms, of the portion of the City and South London Railway between Moorgate-street and Euston. The tunnels on this section were 10ft. 6in. diameter, and they have been increased to the standard dimension of the Underground, viz., 11ft. 8¼in. This has been carried out with the Greathead shield in the manner which has already been described in our columns. In places the use of compressed air was found to be necessary, and illustration Fig. 1 shows the entrance to the compressed air lock at King's Cross. In Fig. 2 may be seen, in the background, the original tunnel and in the foreground the enlarged tube with the Greathead shield in between the two.

Fig. 1—Entrance to Air Lock at King's Cross Station

The contractors for the part of the line between Euston and the Angel were Charles Brand and Son, and thence to Moorgate-street Messrs. Perry and Co. The work included, in addition to increasing the diameter of the tubes, the lengthening of the station platforms, which varied from 150ft. to 200ft. long, to a uniform length of 350ft., so as to accommodate seven-car trains. The track, conductor rails, &c., were taken up and have been replaced, and the necessary alterations to the signals, the lighting, the running of cables, &c., have been done by the company's own staff.

The station at City-road is not to be reopened, its proximity to that at the Angel having made its traffic requirements negligible. The other stations have been reconstructed and escalators are being installed at Moorgate-street and Old-street.

The Camden Town extension, described in The Engineer of March 14th, was opened at the same time as was the line between Moorgate-street and Euston, and through communication was consequently established between Moorgate-street and Hendon and Highgate. The illustration given in Fig. 3 shows the three north-bound tunnels as they approach Camden Town Station. On the right is the original tunnel for the line from Charing Cross to either Hendon or Highgate, which now leads only to Highgate. In the centre background is the line from Moorgate-street to either Hendon or Highgate, and on the left background is the line from Charing Cross to Hendon. This work was, as stated in our previous notice, carried out by J. Mowlem and Co., Limited. Owing to there not being adequate facilities at Moorgate-street—which for the time being is acting as a terminus whilst the remainder of the City and South London Railway is being improved—there can only be a 3¼ minute service for the present.

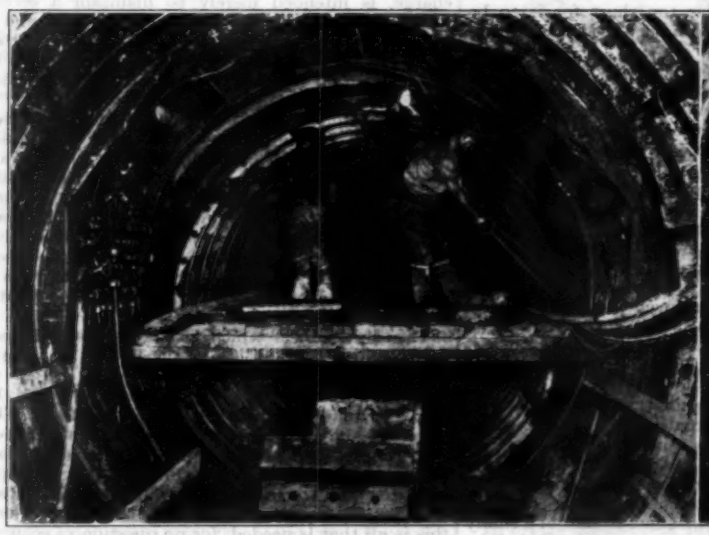


Fig. 2—Old and Enlarged Tunnels and Greathead Shield

Fig. 3—North-bound Tunnels Approaching Camden Town Station

All the foregoing new work has been carried out to plans prepared by and under the supervision of the company's consulting engineer, Mr. Harley H. Dalrymple-Hay.

New rolling stock of a greatly improved type has been provided. Some of the outstanding features we noticed in the new coaches were the silent running, the subdued lighting, the provision of cross seats, preferred by many to the longitudinally arranged, the balanced windows and the ventilation. The doors are opened and closed electro-pneumatically by the

conductor at the rear of the train, and the traction current cannot be switched on unless all the doors are closed. The closing of the doors is cushioned so that no injury is caused to the hand or foot should it be caught between the doors. There are no inside or outside handles, and therefore there is no danger of passengers themselves opening the doors and falling out, while incidentally the possibility of injury to passengers falling when entering or leaving trains in motion is removed.

It is hoped to open the extension from Hendon to Edgware in July and to reopen the line between Moorgate-street and Clapham Common in the autumn. Contracts for the new line from the latter place to Morden are about to be let, and it is trusted that that extension will be completed by the end of next year.

High Elastic Limit Mild Steel and its General Applications.*

By G. W. BARR, F. G. MARTIN and A. T. WALL.

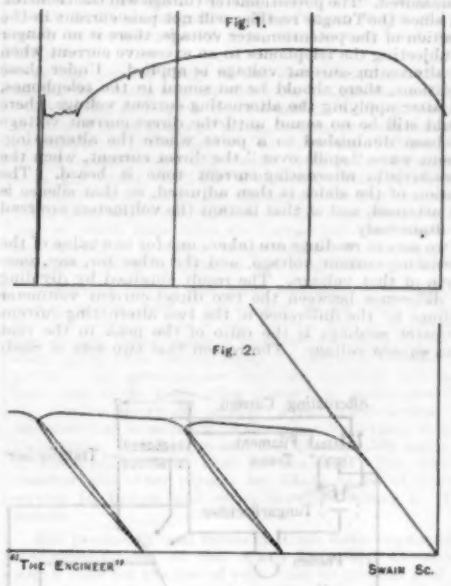
THE object of this paper is to describe a new mild steel which possesses a very high elastic limit and to discuss in quite a general way some of its possibilities. The replacement of iron by mild steel as a shipbuilding material is now looked upon as an event of the first importance, but it took some years to complete the change over. There were many doubts expressed during the transition period, as evidenced by the papers and discussions recorded in the "Transactions" of this Institution. The great advantage claimed for mild steel, at the period when its advantages required advocacy, was its greater ultimate tensile stress, and little was said of its elastic limit. The value of its elastic limit was, however, taken to be near to the yield point, and the yield point was used, and generally is still so used, as a kind of commercial elastic limit.

Recent investigations show that whatever might have been true in the earlier days of mild steel, the value of its elastic limit has for many years been considerably less than what is generally regarded as the yield point. The automatic load extension indicator introduced by Professor Dalby and described before this Institution in 1912 has, with later modifications, made it possible to ascertain accurately and rapidly the elastic limit of a metal, and Professor Dalby is to be congratulated on his production. One of the authors, Mr. F. G. Martin, has carried out thousands of tests with this machine in the ordinary course of his work for the firm of shipowners by whom he is employed. It is found that the elastic limit of ordinary mild steel as used for ship construction is, and always has been, on an average about 8 tons per square inch. It sometimes, but infrequently, has a greater value, as much as 13 to 14 tons per square inch, although this is extremely rare; more often than it has these high values it has values as low as 3 to 4 tons per square inch.

Another point should be referred to in that the yield point of ordinary mild steel may vary considerably depending on the rapidity of the application of the load in the testing machine, and this irrespective of variation in the chemical and other properties of the metal. On the other hand, the elastic limit never varies except with change in the chemical and mechanical constitution of the metal. It has been demonstrated that there is absolutely no constant relation whatever between any two of the three things—elastic limit, yield point, and ultimate stress. It has been the custom to carry out certain mechanical tests on ordinary mild steel intended for use in ships, and these tests have included ultimate stress, elongation, and bending. It has been the practice to assume that if these tests were satisfactorily passed the elastic limit would of necessity be inferentially guaranteed, and this elastic limit value has been assumed to be from 14 to 16 tons per square inch.

As already remarked, tests on ordinary commercial mild steel show the elastic limit to be about 8 tons per square inch. Many hundreds of ships have been built of mild steel which has this elastic limit. Generally speaking, these vessels have given satisfaction, and the scantlings of the steel used in them are standardised in the various rules of the registration societies. It therefore appears reasonable to draw the conclusion that the present standard of strength set up for ships is such that the stresses in the ships do not exceed, at any rate, 8 tons per square inch. The probability is that this statement would meet with general acceptance, but few would be bold enough to give a definite figure for the actual stresses met with in ships.

There is another reason for believing that these stresses are not large, and it arises from experimental tests on riveted joints. As a result of tests on an Admiralty type treble-riveted butt strap connection, it was found that the bead caulking of the butt opened enough for a feeler to be inserted at stresses of 3 to 4 tons per square inch. Further, Dr. Montgomerie's experiments on riveted lap joints would lead to the conclusion that the caulking of the lap must open up at quite small stresses similar to those just



mentioned. In spite of this opening up of the caulking, riveted joints do not leak in practice except in special cases, and while this line of argument may be questioned by some, it does point to the fact that the stresses experienced in ships are not large. The experiments on the destroyer Wolf† indicate that the stresses in a ship are small, and less than those obtained by the usual standard calculations. The scantlings of ships have, so to speak, "grown up," but in recent years they have been modified and often redistributed by the application of comparative scientific methods, and the arrangement of the steel structure of ships is undoubtedly improving continuously in consequence.

NEW MILD STEEL.

There is now in existence a mild steel with a higher elastic limit than ordinary mild steel. Its full title is "a high elastic limit mild steel," but for brevity it will be referred to as "elastic steel." This elastic steel is the development of Mr. F. G. Martin, a metallurgist of Liverpool, and one of the authors of this paper. This elastic steel has an elastic limit of 16 to 17 tons per square inch, as compared with 8 tons for ordinary mild steel. Its ultimate tensile stress is 30 to 35 tons per square inch, not very different from the 28 to 32 tons per square inch for ordinary mild steel. Its ductility is as good as that of ordinary mild steel, as evidenced by its elongation of 20 per cent. in 8in., and this is obviously an important attribute of it. The elastic steel is capable of withstanding continuous reversals of stress to a very much greater extent than ordinary rolled mild steel. It will withstand 10 million reversals at a stress equal to its elastic limit of, say, 16 tons, whereas ordinary mild steel will break down at about 1 million reversals at a stress equal to its elastic limit of 8 tons. The modulus of elasticity of the elastic steel is about 8 per cent. greater than that of ordinary mild steel. Its corrosive properties are the same as those of ordinary mild steel. It is precisely the same material to handle in a shipyard for all purposes as ordinary mild steel. In short, the only practical difference between it and mild steel is that its elastic limit is about twice as great, and its power to resist reversals of stresses more than twice as great, and, of course, its increased modulus of elasticity. The cost of this steel is about 25 per cent. greater than that of ordinary mild steel, but its price would drop as its use became extended, as was the case with ordinary mild steel.

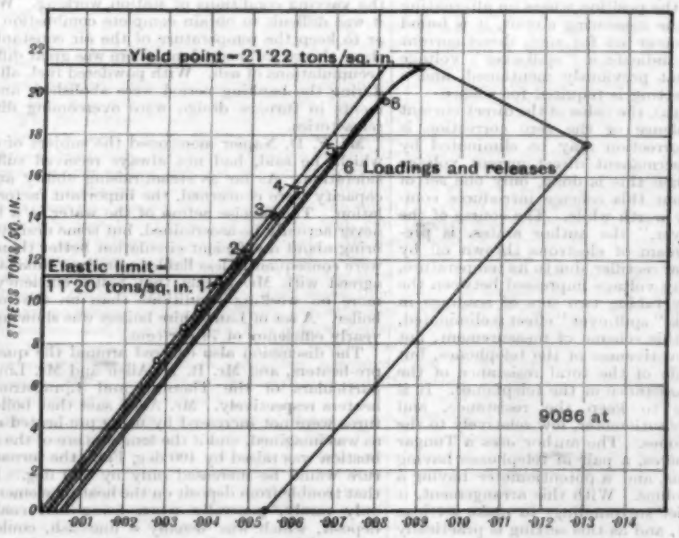

Yield point = 21·22 tons/sq. in.
6 Loadings and releases
Elastic limit = 11·20 tons/sq. in.
9086 at
STRESS TONS/SQ. IN.
EXTENSION (INCHES) IN 5 INS. G.L.
"The Engineer"

FIG. 3

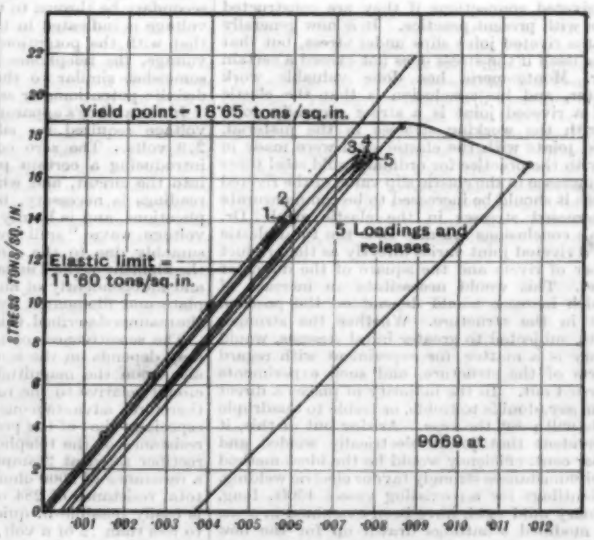

Yield point = 18·65 tons/sq. in.
5 Loadings and releases
Elastic limit = 11·60 tons/sq. in.
9069 at
STRESS TONS/SQ. IN.
EXTENSION (INCHES) IN 5 INS. G.L.
Swain Sc.

FIG. 4

ELASTIC LIMIT AND YIELD POINT.

Some typical load strain diagrams of steel are reproduced in Figs. 1 and 2. Fig. 1 shows the load-strain curve, yield point, maximum and breaking loads, and elongation (extension magnified about 2½ times); while Fig. 2 shows a load-strain diagram on a greatly enlarged scale (extension magnified about 112 times), to facilitate the reading of the elastic limit. The diagram also shows the effect of stressing the material beyond the yield point, and then releasing the load, inducing permanent set. It will be seen that the stress-strain line is straight up to a certain point which is the elastic limit. At this point there is a change in direction, and the line goes on more or less straight up to the yield point, but with a greater slope than before. The Dalby indicator gives the strain by the movements of a spot of light, and if the stress is released when it has a value below or up to the elastic limit, the spot of light will always return to zero. After the elastic limit is passed, the spot of light will not return to zero when the stress is released, indicating that permanent set has taken place in the material.

Figs. 3 and 4 are copied from actual photographic records, obtained with a Dalby extensometer, and show the effect of applying and releasing stresses lying between the elastic limit and the yield point. It is at once apparent that (1) loading a test bar to a stress lying between the elastic limit and the yield point produces permanent set; (2) Successive loadings to the same stress, if this is beyond the elastic limit, produce increasing permanent set. It seems to be axiomatic that no stress in the ship structure should exceed the elastic limit of the material used, as otherwise permanent set will take place, and once this has occurred matters become serious. It would seem also to follow from this that the figure on which the factor of safety should be based is the elastic limit and not the yield point or the ultimate stress. In the past, factors of safety have been expressed in terms of the ultimate stress and this, of course, is quite satisfactory provided the elastic limit of the mild steel bears a constant relation to the ultimate stress.

In comparing two materials of the same ultimate stress, but one with a greater elastic limit than the other, it seems reasonable to allow a greater working stress in the material with the high elastic limit, as compared with the other. This principle was enunciated by the celebrated Dr. Siemens, so far back as 1880, in the "Transactions" of this Institution for that year, pages 216 and 220. Dr. Siemens was using the argument to point out that there was no necessity to increase the ultimate tensile stress of steel if the elastic limit was not increased with it. In this connection, the use of high-tensile steel has not found so much favour in recent years, due, it is thought, to the fact that the elastic limit was not increased in the same proportion as the ultimate stress. It follows that when the new elastic steel is used in any structure, it is permissible and sound policy to allow an increase in the direct tensile stress in the structure. Viewed from this standpoint alone, the direct tensile working stress may be doubled in the elastic steel compared with those in ordinary mild steel.

APPLICATIONS OF ELASTIC STEEL.

Stresses in a ship are produced in four principal ways:—

(*a*) *Longitudinal Stresses.*—The main longitudinal stresses due to the straining action of a ship on waves and calculated in accordance with the established procedure.

(*b*) *Transverse Stresses.*—The stresses due to trans-

* Institution of Naval Architects.

† See "Transactions," I.N.A., Vol. XLVII., Part I., page 80.

verse strains in which the frame and its proportionate amount of shell plating is considered as a girder.

(*c*) *Pressure Stresses.*—The stresses due to water pressure and cargo or other loads on the plating.

(*d*) *Local Stresses.*—The stresses due to slamming, panting, concentrated loads, machinery, &c.

It will rarely, if ever, happen that any part of a ship's structure is at all times subjected to a pure tensile stress, but dealing with the tensile stress only under the above headings, the following general remarks would apply:—From considerations under (*a*), since the form of the girder remains exactly the same, it only becomes necessary to reduce the thickness of the various plates and angles in the proportion of 1 to 2. From considerations under (*b*), the reduction in thickness of the shell plating brought about by considerations under (*a*), (*c*) and (*d*), will reduce the transverse strength, and it would remain to adjust the size of the framing, so that the transverse tensile stresses are reduced in the ratio of 1 to 2. From considerations under (*c*), it has now been sufficiently demonstrated that the stresses in the shell plating due to water pressure or uniform loading of cargo varies inversely as the square of the thickness of the plating, and in considering these stresses, the thickness of the plating would be reduced in the ratio of 1 to the square root of 2. From considerations under (*d*), special and local stiffening would still have to be fitted to meet these stresses, but the scantlings can be reduced in the same considerations as apply under (*c*). It is not proposed to attempt to give in this paper any details with regard to actual reduction in scantlings that would be possible. It is necessary to work these out very carefully in the different parts of the structure, so that in some cases the possible reduction in scantlings would be greater than in others. This would form subject matter for more than one additional paper.

With regard to compressive stresses, failure under compression occurs by secondary flexure or buckling, and this kind of failure is difficult to treat with exactitude. It is true to say that failure by secondary flexure is failure due to shear, and the new elastic steel has an improved elastic limit for shear stress. Dr. Montgomerie, however, has given a lead in this connection in a paper in "Stress Determination in Flat Steel Plates," read before this Institution in 1919.‡ In this paper he said that the plating of a ship can transmit compressive stresses of considerable magnitude at much wider spaces than are adopted in a ship. It is also true that since the thickness of the longitudinal material cannot be reduced in the inverse proportion of the elastic limits when viewed from the standpoint of longitudinal stresses alone, there is something in hand to set off against an increased compressive stress. In any case, increased compressive stresses can be readily carried by flat plating, provided it is given sufficient stiffening. There should be no fear, within reasonable limits, of the failure due to compression in the bottom shell plating, which is very well stiffened under present methods of construction. The plating of the top deck amidships might require additional stiffening to resist compressive stresses, as is the case in many ships to-day. This would be a good thing to do and should take the form of longitudinal stiffening, when all fear of failure by secondary flexure under compression would disappear. This matter would require careful attention, but there is no doubt that a reduction of scantlings would be possible. No good purpose would be served by elaborating this matter of the actual reduction in scantlings any further, as it would introduce a long detailed account which is not intended for this paper.

JOINTS.

Some remarks should be made on the method of jointing the new elastic steel. While elastic steel has a greater elastic limit than the old steel, the same is not true of the riveted connections if they are constructed in accordance with present practice. It is now generally accepted that a riveted joint slips under stress, but that it will recover itself if the stress does not exceed a certain amount. Dr. Montgomerie has done valuable work on this matter, and his conclusion is that the elastic slip limit of a riveted joint is a stress generally commensurate with the working stresses in the material. If the riveted joints with the elastic steel were made in accordance with the practice for ordinary mild steel there would be no increase in the elastic slip value of the riveted joints, whereas it should be increased to be commensurate with the increased stresses in the elastic steel. Dr. Montgomerie's conclusions are also that the total elastic slip value of a riveted joint varies directly as the product of the number of rivets and the square of the diameter of each rivet. This would necessitate an increase of riveting, which increase would depend on the position of the joint in the structure. Whether the stronger riveted joints, subjected to greater inital stresses, would be satisfactory is a matter for experiment with regard to some parts of the structure, and such experiments are to be carried out. In the majority of places a direct increase from, say, double to treble, or treble to quadruple riveted joints will meet the case. Arising out of this, it seems self evident that joints electrically welded and giving 100 per cent. efficiency would be the ideal method to use, and circumstances strongly favour electric welding. The steel scantlings for an existing vessel 450ft. long, built of ordinary mild steel, have been examined in some detail, and modified scantlings drawn up for the new elastic steel. It was found that erring very much on the side of safety, for the new elastic steel, it was possible to effect a saving of 12½ per cent. in the steel weight or a saving of 400 tons in the weight of the light ship, giving that much gain in the deadweight carrying capacity of the ship. It was also estimated that the increase in the total cost of the ship would not exceed 3 to 4 per cent., which would be easily set off by the additional earnings of the increased deadweight capacity.

For bridge construction the new steel will be invaluable, when it is remembered that by far the greater proportion of the steel work must be fitted to carry its own weight, and only a small proportion is required to carry the load. The matter of the application of this new elastic steel to the construction of a ship has now reached a very definite stage, so much so that a vessel will shortly be constructed of the new material, and it seems that the changes from ordinary mild steel to the new high elastic limit mild steel should have far-reaching consequences.

‡ "Transactions," I.N.A., Vol. LXI., page 281.

The Measurement of Peak Voltages.

AN ingenious method of measuring the peak value of voltage waves is described by Mr. Ralph D. Mershon in the February issue of the *Journal* of the American Institute of Electrical Engineers. A rectifying valve is used to rectify the voltage, or a portion of it, and this voltage is balanced against a direct-current voltage by using a pair of telephones, as shown in the diagram, Fig. 1. The method of operation is similar to that of any potentiometer scheme, but an indication of unbalance is only obtained when the balancing direct current is less than the peak to be measured.

When about to take a reading, the direct current is applied to the circuit before the alternating current, and the potentiometer is set for a direct-current voltage considerably in excess of the estimated value of the peak to be measured. The potentiometer voltage will then control, and since the Tungar rectifier will not pass current in the direction of the potentiometer voltage, there is no danger of subjecting the telephones to an excessive current when the alternating-current voltage is applied. Under these conditions, there should be no sound in the telephones, and after applying the alternating-current voltage, there should still be no sound until the direct-current voltage has been diminished to a point where the alternating-current wave "spills over" the direct current, when the characteristic alternating-current tone is heard. The position of the slider is then adjusted, so that silence is first attained, and at that instant the voltmeters are read simultaneously.

Two sets of readings are taken, one for one value of the alternating-current voltage, and the other for, say, one-fourth of that voltage. The result obtained by dividing the difference between the two direct-current voltmeter readings by the difference of the two alternating-current voltmeter readings is the ratio of the peak to the root mean square voltage. The reason that two sets of readings must be taken is that there is a zero correction to be dealt with. If the single-pole switch on the transformer secondary be thrown to the position where no alternating voltage is indicated in the measuring circuit, it is found that with the potentiometer set for zero, direct-current voltage, the telephones indicate a "spill-over" voltage somewhat similar to that previously mentioned, and a definite potentiometer setting is required for silence.

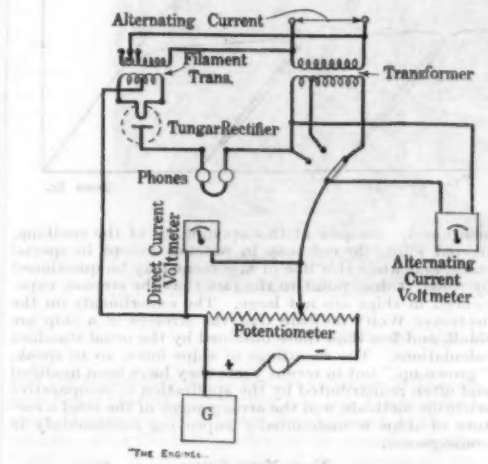


FIG. 1

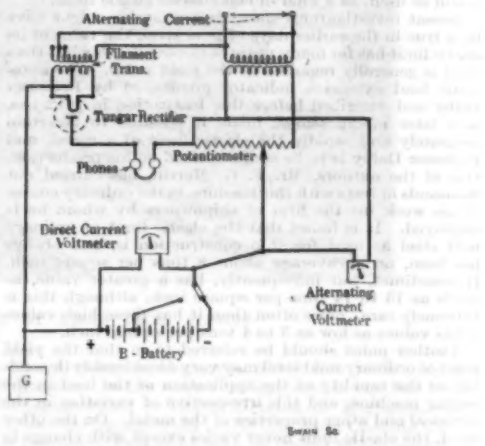


FIG. 2

In the author's apparatus, the value of the direct-current voltage required for silence or the zero correction is 2.9 volts. The zero correction may be eliminated by introducing a certain permanent direct-current voltage into the circuit, and when this is done, only one set of readings is necessary, but this scheme introduces complications, and is hardly worth while. The course of the voltage wave "spill over," the author states, is presumably due to the stream of electrons thrown off by the filament of the Tungar rectifier, due to its temperature, and independently of any voltage impressed between the plate and filament. By taking two sets of readings in the manner described, this "spill-over" effect is eliminated.

The sensitiveness of this scheme of measurement, not only depends on the sensitiveness of the telephones, but also upon the magnitude of the total resistance of the circuit relative to the resistance of the telephones. It is therefore advantageous to keep the resistance, and especially that of the potentiometer, low relatively to the resistance of the telephones. The author uses a Tungar rectifier rated at 2 ampères, a pair of telephones having a resistance of 2000 ohms, and a potentiometer having a total resistance of 284 ohms. With this arrangement, it is easily possible in quiet surroundings to make settings to less than .2 of a volt, and as this setting is practically independent of the magnitude of the peak measured, the greater the peak the lower is the percentage error due to the setting. If greater accuracy is desired, or if the surroundings are noisy, an amplifier may be used in connection with the telephones. An earth connection G is shown, and although it is not absolutely essential, it tends to reduce noise in the telephones.

A modification of the scheme is shown in Fig. 2, the direct-current voltage in this case being kept constant, whilst the alternating-current voltage is varied. The arrangement shown in Fig. 1 must be used when no current may be drawn from the circuit which is under test; whilst the scheme shown in Fig. 2 may be employed when it is permissible to take current from the circuit. The latter arrangement offers the advantage that if no direct current is available, a battery may be used as shown. Moreover, if the operating voltage of the battery is accurately known and can be depended upon to remain constant, the direct-current voltmeter may be omitted. At first an endeavour was made to check the scheme by substituting a direct-current voltage for the alternating-current voltage, this voltage being periodically applied by opening and closing a switch, but it was found that the results obtained in that way were not always correct.

Water-tube Boilers.

THE following report of the discussion on April 11th of Mr. L. M. Jockel's paper "Water-tube Boilers," read before the Junior Institution of Engineers, has been supplied by the Secretary of the Institution:—In his paper Mr. Jockel had suggested that the boiler of the future would use powdered fuel, and would have the furnace refractories cooled by the feed water. Mr. Charles Erith pointed out that water cooling in the furnace was a very difficult problem, and in cases in which the whole of the furnace walls were water screened, a very considerable proportion of the steam was generated in these accessory boiler heating surfaces, which constituted a sort of huge "bird-cage" extension of the boiler proper. Powdered fuel only increased these difficulties. He said that he thought the boiler of the future would be of the simplest character, stoker-fired, and without water screens, furnace arch or flue gas air heater, the air for combustion being heated by using hollow furnace walls. Mr. Erith quoted an American test on a stoker-fired boiler with economiser but no pre-heater, showing an efficiency of 92.7 per cent. Mr. Jockel said, however, that he was not prepared to believe any efficiency over 90 per cent.

Mr. R. F. Evans put forward some of the advantages which powdered fuel gave in spite of its cost. He said that this was the era of bigger turbines and consequently bigger boilers, and one immediate effect of powdered fuel firing was that it increased the capacity of a boiler. For a boiler being converted to burn powdered fuel, a guarantee was given to increase the evaporative capacity from 35,000 lb. per hour to 77,000 lb. per hour. Powdered fuel showed better efficiency than stoker-fired boilers under the varying conditions of station working. With stokers it was difficult to obtain complete combustion of the fuel or to keep the temperature of the air constant, or, when those things had been done, there was great difficulty with accumulations of ash. With powdered fuel, all heat losses during the banking period were abolished, and improvements in furnace design were overcoming difficulties of refractories.

Mr. F. D. Napier mentioned the subject of circulation, which, he said, had not always received sufficient consideration. As far as steam-raising ability and ultimate capacity were concerned, the important factor was circulation. The precise action of the water in a boiler could never actually be ascertained, but some designs seemed to bring about a sufficient circulation better than others and were consequently less liable to produce tube failures. He agreed with Mr. Jockel that boiler efficiency depended more on working conditions than on the make of the boiler. A set of Lancashire boilers was showing an overall yearly efficiency of 74 per cent.

The discussion also centred around the question of air pre-heaters, and Mr. R. H. Allen and Mr. Lindkirst gave particulars of the Thermix and Ljungstrom air pre-heaters respectively. Mr. Allen said that boiler temperatures were not increased by using pre-heated air so much as was imagined, and if the temperature of the air for combustion was raised by 400 deg. Fah., the furnace temperature would be increased only by 300 deg. It was said that trouble from deposit on the heating elements occurred only rarely, generally when using bad coal, and any deposit, which was usually a fine ash, could easily be removed by a jet of steam or by increasing the flue gas velocity. The amount of energy absorbed by air pre-heaters was very small, not more than 0.5 per cent. of the total boiler output. Mr. Jockel gave details of a new test on a Ljungstrom pre-heater, showing a saving of fuel to the extent of 13.6 per cent., after taking into account the energy absorbed by the fans.

Mr. R. H. Parsons, who was in the chair, mentioned the excellent efficiency which was being obtained at the Barton power station, and said that such efficiencies would probably become more common in this country with the advent of bigger stations.

As the cost of living had not varied 5 points on March 1st since the men in the conciliation grades were given an extra shilling on January 1st last, there will be no change in their pay as from the 1st inst.

Railway Matters.

THE directors of the London and North-Eastern Railway have appointed Mr. A. F. Bound to be the signal engineer of the southern area, and Mr. A. E. Tattersall to be assistant signal engineer. They have also appointed Mr. F. Downes to be telegraph superintendent of the southern area.

FOR the intended improved services on the Great Eastern section of the London and North-Eastern Railway, twenty-nine new trains of ten coaches each have been ordered from outside firms. Each train will be on the Gresley articulated principle, with two sets of five coaches carried on six four-wheeled bogies.

IT is a satisfaction to hear that the latest order for locomotives for India has been given to a British firm. The Vulcan Foundry Company, Limited, of Newton-le-Willows, received information last Saturday that its tender for forty broad-gauge locomotives for the East Indian Railway had been accepted.

THE Enfield branch of the Great Northern Railway was extended from Enfield to Cuffley in 1909 as part of a duplicate main line between Wood Green and Stevenage. The remainder of the work was put in hand later, and was nearly completed when the war stopped operations. Its equipment for goods traffic was later resumed, and the line was opened for goods trains in February, 1921. It is now being completed, and signalled for passenger running, and is to be used for such as from June 2nd.

IN this column of THE ENGINEER of February 22nd last we mentioned that Mr. W. A. Webb, the Chief Commissioner of the South Australian Railways, had been invited to report on the Tasmanian Government Railways. Mr. Webb's report has now been issued, and therein the opinion is expressed that the present unsatisfactory conditions are due to wages and the price of material being higher than the revenue warrants, to motor competition, and to excessive capital cost. Mr. Webb recommends that the successor to the late Railway Commissioner be paid £2500 a year—£1000 more than his predecessor—and that no new construction be authorised except with his approval.

ACCORDING to the Board of Trade returns, the exports of railway material during the month of January last were of the following value, the corresponding figures for 1923 and 1922 being added in brackets:—Locomotives, £209,483 (£253,344, £863,981); rails, £185,616 (£139,243, £416,585); carriages, £132,561 (£202,346, £106,592); wagons, £274,210 (£191,077, £529,909); tires and axles, £57,770 (£32,777, £67,095); wheels and axles, £45,630 (£70,238, £153,366); chairs and metal sleepers, £141,139 (£30,840, £211,876); miscellaneous permanent way material, £116,100 (£111,091, £173,162); total permanent way material, £559,951 (£407,634, £1,046,063). The weight of the rails exported was 21,841 tons (16,583 tons, 35,928 tons); and of the chairs and metal sleepers, 11,738 tons (2704 tons, 13,527 tons). Of the locomotives, £131,385 worth were sent to India, and of the rails, £67,114 to Africa, £33,744 to India, and £29,628 to New Zealand.

THE Great Western Railway Company seeks, in its Bill now before Parliament, powers for additional accommodation at Saltney, near Chester. In this Bill is involved the question of shunting over a level crossing at that station. Parliament has always been very jealous of the public rights where railways cross a highway on the level. Of the many restrictions placed on railway companies under this head, the particular one relating to shunting is contained in the following clause in the Requirements as to New Railways: "Sidings connected with the main line near a public road level crossing to be so placed that shunting may be carried on with as little interference as possible with the level crossing; and, as a rule, the points of the sidings to be not less than 100 yards from the crossing." On the Great Western Company undertaking that the crossing shall not be obstructed more than is necessary for the traffic, the clause was passed.

THE railway accident which took place in Switzerland on Wednesday last was one of the most terrible that has occurred. The St. Gothard express, coming from Milan in the south, collided with the St. Gothard express, coming from Lucerne in the north. For some unknown reason, the north express driver either did not see or ignored the signals which were against him outside Bellinzona Station. The north express was coming at full speed, but the south express had only just left Bellinzona Station, and, consequently, had not attained its highest speed. All the engine-drivers and their assistants were killed. One of the engines was completely destroyed, and the other three badly damaged. On the express coming from Milan there was a German passenger coach, lighted by gas, attached next to the engine, and it caught fire. It is not yet known how many passengers it contained, as the coach was entirely consumed by the flames. Another passenger coach, belonging to the Italian State Railways, also caught fire, but the passengers were rescued.

IN the Journal page of THE ENGINEER of February 8th the announcement was made that the Inter-State Commerce Commission had ordered each of the forty-nine railways which are to fix an installation of automatic train control by January 1st next, to provide a second installation. It also ordered forty-five other roads to fix one installation each. This last order was protested against on the grounds that the additional carriers named in the Commission's order of January 14th, 1924, had no notice of this proceeding, no notice of the intention of the Commission to make the order, and that the order was made without a hearing, either of the carriers parties to the order of January 10th, 1922, or of the additional carriers; that many of such last-named carriers were carriers with small traffic, with small net revenues, or no net revenues, with infrequent trains, both freight and passenger, and with no installations of automatic signals; that upon such lines no necessity existed for the installation of automatic signals, or of automatic train control, for the reason that traffic upon such lines was so light that no additional safety in the operation thereof would be attained by the installation of either. The forty-nine companies protested also against the second installation, and, further, asked that the time limit be extended for another twelve months. The Commission has now agreed to hear the forty-five companies' appeal, but has refused the others.

Notes and Memoranda.

IN the course of a paper read before the Birmingham section of the Society of Chemical Industry, Mr. F. J. C. China suggested the use of an emulsion of petrol as a fuel for internal combustion engines. It was, he said, necessary to use from 1 to 2 per cent. of ammonium oleate as a stabiliser, and with an emulsion containing 30 per cent. of water the same miles per gallon had been obtained with a car as with plain petrol.

AT the annual meeting of the Swedish Water Power Association it was stated that the water power in Sweden exploited according to modern methods totalled 1,530,000 horse-power at the beginning of 1924. The power produced during 1923 by those works was estimated at about 3000 million units. Power works are under construction at Lilla Edet with a capacity of about 30,000 horse-power, and at Lanforsen on the Dal River, with a capacity of about 33,000 horse-power. The former works will probably be completed next year, and those at Lanforsen in 1927.

IN the general study of the electrical conductivity of refractories being conducted by the United States Department of the Interior at the Columbus, Ohio, Experiment Station of the Bureau of Mines, tests have been completed on Maryland, Indian and Italian talcs from 500 deg. Cent. to and including 1000 deg. Cent. These talcs at the present time are being used for the manufacture of electrical insulators and cores for electrical heating appliances. Since 1000 deg. Cent. represents the maximum temperature at which these talcs are burned and used, tests were not carried to a higher temperature. Preliminary tests have been made on diaspore and magnesite.

NORWAY'S newest and most northerly radio station is now completed, and in commission at the town of Vardoe. For the present, only a day service will be maintained. The station, while being of moderate power, is fitted with most up-to-date instruments, including a wireless telephone. The antennæ are stretched between two masts, each over 150ft. high. The power will be supplied from the Vardoe electricity works. Final transmission trials revealed that in addition to the other Norwegian stations, Helsingfors, Spitzbergen and Jan Mayen—300 miles east of Greenland—could also be reached. The station's weather and other reports are likely to be of immense service to British and other trawlers fishing in Arctic waters.

ALL producing coal mines in Utah have approved the recommendations of the State Industrial Commission which calls for the use of rock dust to prevent coal dust explosions; the use of water on the cutter bars of mining machines to decrease the amount of dust formed; the invariable use of closed lights, and the use of only permissible explosives ignited by electric methods. According to a communication received from the Bureau of Mines, Department of the Interior, these requirements are the result of an intensive study of safety precautions made by the industrial commission after the mine disaster at Castle Gate, Utah, on March 9th, in which 174 men lost their lives. Utah is the only state which has as yet required all these safety precautions, and it takes the lead among all coal-mining states in regulations for mine safety. The numerous coal dust explosions of the past few years, some of which have occurred in what were considered well watered mines, have caused mining men to be suspicious of the efficiency of watering. The Bureau of Mines officials state that watering as a general method is a failure, and urgently recommend rock dusting.

ACCORDING to the estimates prepared by the Swiss Federal Railway Administration for 1923, the operation of the railways was expected to result in a deficit of 25,000,000f., but as a result of increased receipts and a reduction in expenses last year closed with a surplus of about 3,000,000f. Encouraged by these results, the Swiss Federation recently offered for subscription a further loan in order to provide funds for proceeding with the work of electrification. The rapid sequence of such loans has raised the question as to the economic justification for the large expenditure involved in the great scheme of conversion to electric traction. On this point, it is known that after the work of conversion of a total length of 970 miles of line proposed to be electrified is completed, the total consumption of coal will be 450,000 tons less per annum than when steam locomotion was in operation, on the basis of the traffic handled in 1913. At the price of 60f. per ton of coal, this represents a sum of 27,000,000f. per annum, which will no longer have to be paid to other countries for deliveries of coal. It is also of importance to note that most of the expenditure on the work of conversion is incurred in Switzerland. The more the traffic increases, the more economical electrical working will be, to say nothing of the other advantages of higher speed and the greater power of the electric locomotives which permits the haulage of heavier trains.

A PRELIMINARY report has been presented by Mr. C. H. Thirkell to the Board of Trade upon a boiler explosion which occurred in the Aberdare municipal power station on November 29th last. Seven men were injured, one of whom died subsequently. The boiler was of the marine water-tube type, having 280 tubes, 4in. in diameter. The boiler was about thirteen years old, and a number of repairs had been made from time to time, including the replacement of a defective tube in May, 1922. The explosion occurred in the new tube, which was ruptured longitudinally for a length of about 11in. The opening formed was 5¾in. at the widest part, and through it the contents of the boiler escaped. The explosion was due to overheating of the metal, caused by the accumulation of a sedimentary deposit in the tube. Although the installation is provided with a water-softening plant, an inspection revealed the fact that the tubes adjacent to the ruptured one were more than half full of loose sedimentary deposit, and the removal of more caps disclosed the same condition in other rows of tubes. In his observations, the Engineer Surveyor-in-Chief states that the owners had gone to a great deal of pains and expense to ensure a pure boiler feed. More frequent "blowing down" might have been advantageous, and visual inspection should have been made with sufficient frequency to ensure that the tubes were clean.

Miscellanea.

A NEW bridge is to be built across the river Usk at Newport, at a cost of over £140,000.

IT is reported that the facilities at Alexandra Docks, Newport, are to be extended at a cost of £1,000,000.

THE extension of the Birmingham tramways towards the Lickey Hills—a sleeper track running alongside the roadway—was opened as far as Rednal on the 14th inst.

A COLD storage capable of dealing with 450 head of sheep and cattle a week is to be put up at Walvis Bay, South-West Africa. The cost of the scheme is put at £250,000.

THE American House of Representatives has approved a Bill providing 25,000,000 dollars yearly for the purpose of converting United States Shipping Board ships that are actively engaged in foreign trade into Diesel motor types.

APPROXIMATELY 5,000,000 dollars will be spent by the Dominion Coal Company to open up a new mine and colliery at Lingan, Nova Scotia. The construction of a branch line of railway to the new site has been started. The new colliery will have a capacity of some 2000 tons daily.

IT is announced in the *Chemical Trades Journal* that as a result of the experiments in the manufacture of synthetic ammonia which have been carried out recently in Spain, the question is being considered of forming an industrial company with a large capital to undertake the manufacture of synthetic ammonia on a large scale.

A FEW days ago Mr. Brown asked the Minister of Agriculture whether the Ministry would give any information as to the use of electrical devices in farming. Mr. Buxton said if the hon. member meant by electrical devices the use of electrical discharges for the purpose of stimulating plant growth, which was commonly called electro-culture, this question was being dealt with by a special committee under the chairmanship of Sir John Snell. The committee had issued a series of reports on the subject, summaries of which had appeared in the Ministry's *Journal*.

THE monthly return by the National Federation of Iron and Steel Manufacturers shows that the production of pig iron in March amounted to 668,600 tons, compared with 612,700 tons in February and 633,600 tons in March, 1923. The number of furnaces in blast at the end of March was 194, a net decrease of eight compared with February. The production included 214,800 tons of hematite, 235,100 tons of basic, 150,200 tons of foundry and 36,500 tons of forge pig iron. The output of steel ingots and castings in March amounted to 825,200 tons, compared with 767,600 tons in February and 802,500 tons in March, 1923.

AT a recent meeting, the Council of the British Engineers' Association unanimously adopted the following resolution:—"The Council of the British Engineers' Association view with grave concern the decision of H.M. Government not to introduce legislation to extend the duration of the provisions of Part II. of the Safeguarding of Industries Act which deal with the making of Orders on the ground of depreciation of foreign currency. Their concern is not limited to the decision itself, but extends to its implications as indicating the attitude of the Government towards the manufacturing industries of the country in their present struggle with adversity at a time when the most urgent need is to provide increased wealth productive employment for our people."

A NEW wages agreement arrived at by the Joint Conciliation Board, representative of the Brassfounders Employers' Association and the National Brass and Metal Mechanics' Society, has been finally approved this week. It provides for an advance of 1d. per hour to men of all grades. The agreed bonus will therefore be 21s. 6½d. per week of forty-seven hours. The bonus for youths between eighteen and twenty-one is to be increased by ½d. per hour, making their total bonus 11s. 4d. Where foremen are engaged at a fixed wage the above advance will not apply unless by arrangement between employer and employed, but the Conciliation Board considers it is only reasonable that where a man has suffered a reduction on the last occasion he should benefit by the increase now suggested.

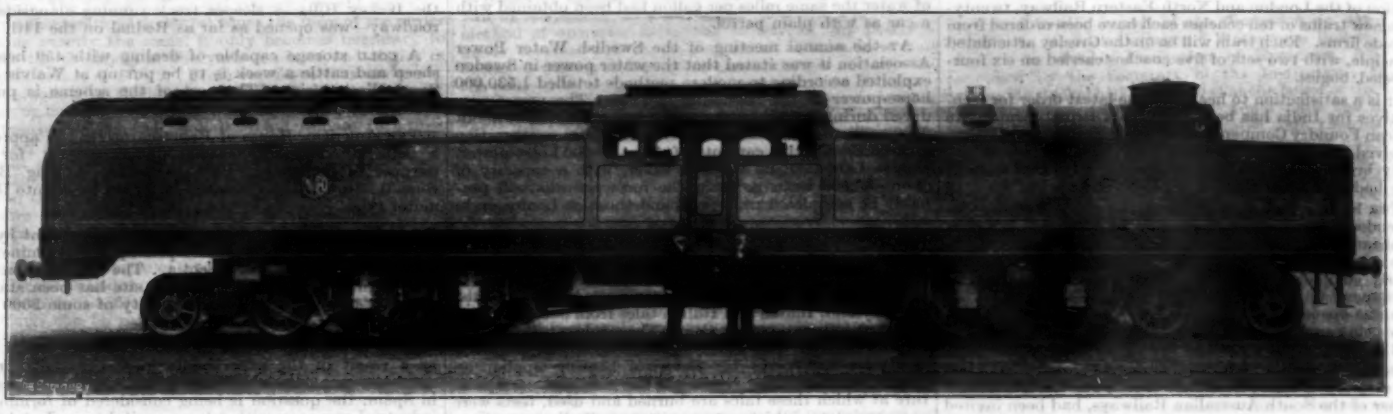
RECENTLY the Preston Town Council, at the invitation of the chairman of the Electricity Committee, paid a visit to the Ribble power station now in course of construction and rapidly approaching completion. The buildings, of the steel-frame type, are constructed of brick and concrete, reinforced with steel girders, and comprise a boiler-house, turbine room, and office and switchgear building. The plant being installed consists of five Babcock and Wilcox boilers, which will supply steam to two turbo-generators, each capable of an output of 12,500 kilowatts. Accommodation is also provided for a third set of similar capacity to be installed at a later date. The current will be generated at 6600 volts. The switchgear has been installed by Metropolitan-Vickers Electrical Company, Limited.

A REPORT on the supply of electricity to Deeside has been submitted by the Aberdeen chief electrical engineer to the Corporation's Electricity Committee. The report states that to meet the increasing demand for electricity and to improve the supply, a change-over from direct current to alternating current in the Deeside district is being carried out in sections. The work in the Cults central area was completed on February 24th of last year, whilst the work in the Culter area was finished on December 7th. The electrical engineer urges that a portion of the area extending eastwards from the Cults central area and at present containing 147 consumers should be changed over this summer. As regards the remaining western portion of the district from Bieldside, authority was sought to arrange for a site on which to erect an inexpensive galvanised iron sub-station to house a static transformer and switchgear, and to lay a 6600-volt cable. The report was adopted, and if possible it is proposed to complete the latter work before next winter.

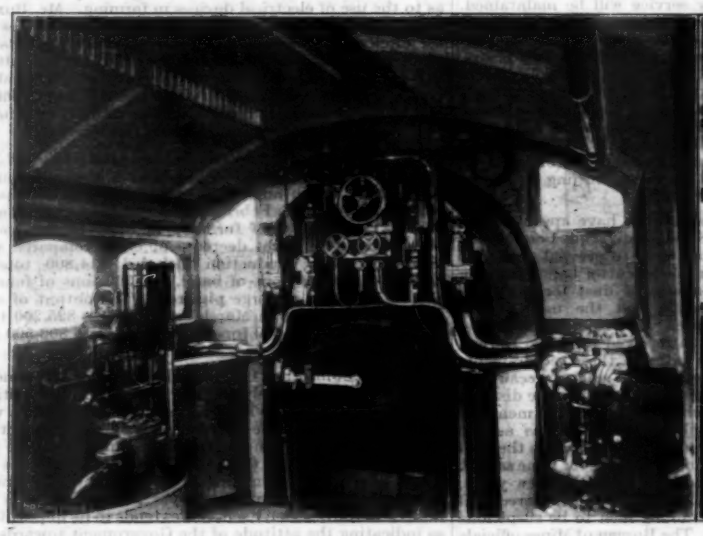
EMPIRE EXHIBITION—GEARED STEAM TURBINE CONDENSING LOCOMOTIVE

NORTH BRITISH LOCOMOTIVE COMPANY, LIMITED, GLASGOW, ENGINEERS

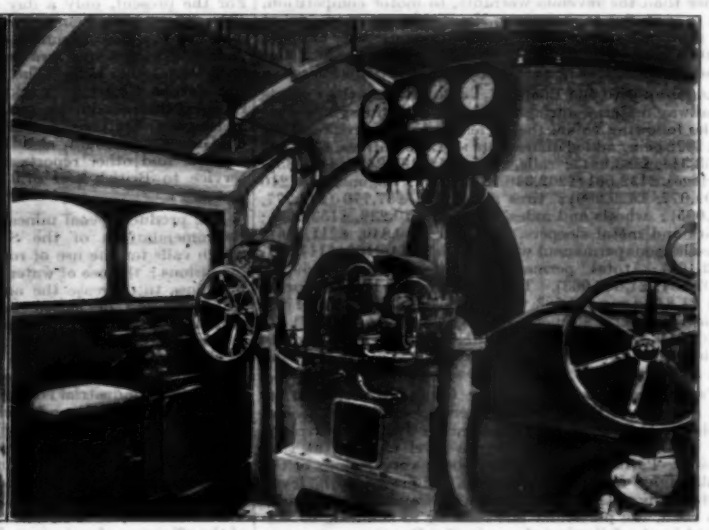
(*For description see page 436*)



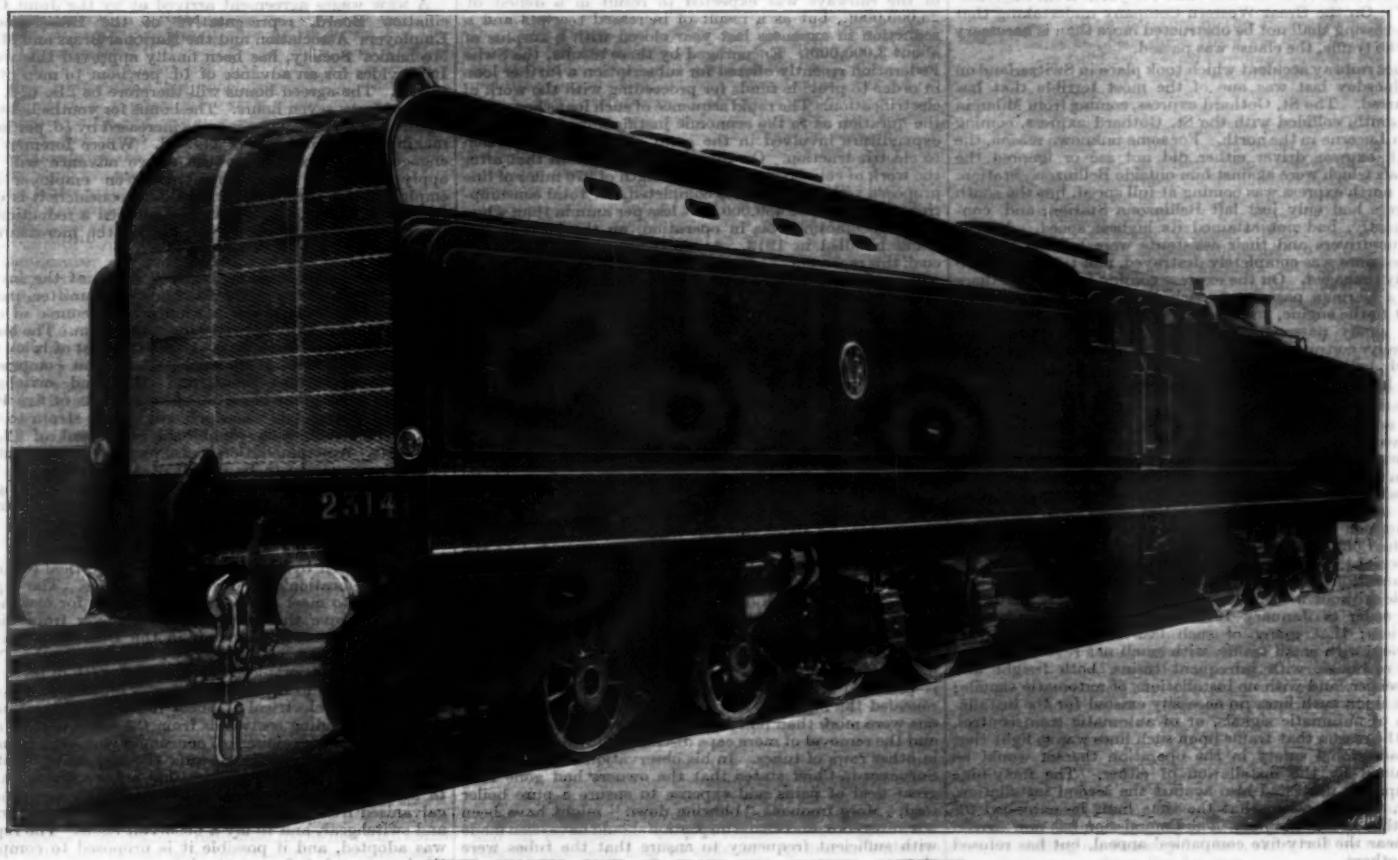
SIDE VIEW OF THE REID-MACLEOD TURBINE LOCOMOTIVE



INTERIOR OF CAB—FIREMAN'S END



INTERIOR OF CAB—DRIVER'S END



THREE-QUARTER VIEW OF FRONT END SHOWING CONDENSER

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By arrangement with Reuter's Engineering Service, The Engineer *contains the latest news from all parts of the world which is likely to be of interest to engineers.*

Contents.

The Engineer, April 25th, 1924.	PAGE
A Seven-day Journal	429
The British Empire Exhibition, No. I. (Illus.)	430
Water Power Resources of Canada	439
The Design of Works in Open Channels. (Illus.)	440
The Camden Town Tube Extension. (Illus.)	442
High Elastic Limit Mild Steel and its General Applications. (Illus.)	443
The Measurement of Peak Voltages. (Illus.)	444
Water-tube Boilers	444
Railway Matters	445
Notes and Memoranda	445
Miscellanea	445
Leading Articles—	
The Exhibition	447
Communication Circuits	448
Literature	448
Sixty Years Ago	449
Letters to the Editor—	
The Specific Heat of Gaseous Mixtures	449
Institution of Naval Architects. No. III.	450
A Sliding Cylinder Two-cycle Double-acting Marine Oil Engine. No. I. (Illus.)	451
An Experimental River. (Illus.)	452
L.M.S. Railway 4–6–4 "Baltic" Tank Engines. (Illus.)	454
A Self-adjusting Ring Spanner. (Illus.)	454
Churches and Office Buildings	454
Large Pipe Joints. (Illus.)	454
The Application of the Steam Turbine for Auxiliary Machinery. (Illus.)	455
A Large Crank Axle Lathe. (Illus.)	457
South African Oil Shales	457
Electrically Operated Pumps in Industrial Plants. (Illus.)	458
Launches and Trial Trips	459
Personal and Business Announcements	459
Contracts	459
Provincial Letters—	
The Midlands and Staffordshire	459
Lancashire	459
Sheffield	460
North of England	461
Scotland	461
Wales and Adjoining Counties	461
Catalogues	461
Current Prices for Metals and Fuels	462
French Engineering Notes	463
British Patent Specifications. (Illus.)	463
Forthcoming Engagements	464

THE ENGINEER.

APRIL 25, 1924.

The Exhibition.

On Wednesday last the Great Exhibition at Wembley was opened by the King in the presence of a vast concourse. It is a fact of not a little significance that one of the most recent products of science was used to make his Majesty's voice audible without effort, not only from one end of the Stadium to the other, but even, through the medium of wireless telephony, to far parts of Europe. There is no development of the present century more remarkable than the transmission of human speech over enormous distance, and there was something peculiarly fitting in the very first act connected with an Exhibition which owes so much to science being performed by the aid of science. "The Exhibition," said his Majesty, "may be said to reveal to us the whole Empire in little, containing within its 220 acres of ground a vivid model of the architecture, art and industry of all the races which come under the British flag. It represents to the world a graphic illustration of the spirit of free and tolerant co-operation which has inspired peoples of different races, creeds, institutions, and ways of thought to unite in a single commonwealth and to contribute their varying national gifts to one great end. It will enable us to take stock of the resources, actual and potential, of the Empire as a whole; to consider where these exist and how they can best be developed and utilised; to take counsel together how the people can co-operate to supply one another's needs; and to promote national well-being. We believe that this Exhibition will bring the peoples of the Empire to a better knowledge of how to meet their reciprocal wants and aspirations, and that where brotherly feeling and the habit of united action already exist the growth of inter-Imperial trade will make the bonds of sympathy yet closer and stronger."

It is now too late to speak of errors committed during the creation of the Exhibition and too early to discuss its achievement. Many visits must be paid to the numerous palaces and halls before a just conception of the magnitude and completeness of the design can be secured. It is rather with the spirit and intention of the Exhibition than with its execution that we must deal to-day. It was not conceived in any boastful or vainglorious spirit. It is not intended merely to exhibit to a gaping and astonished world the might and extent of the British Empire; it is not designed to humble other nations by the contemplation of the resources of an Empire which is by far the richest the world has ever seen. No such thoughts, we are convinced, have ever passed through the minds of those in whose hands the management of the Exhibition reposes or of those who are displaying their products in its palaces. If we understand it aright, the prime appeal of the Exhibition is to the peoples of the British Empire. Divided by many thousands of miles, separated by diversity of tongues, lacking unity of outlook owing to differences of race, of climate, of social conditions and natural resources, a complete conception of the Empire is denied to all but a few who have the time, the inclination, and the means to study its many details and the superlative intelligence that is required to harmonise its diverse units. The Exhibition gives to all, what has hitherto been reserved for but few, the opportunity to see the Empire as a whole. That is a great conception. It is true that they must see it through reversed lenses; that what is presented to them is no more than a reduced image. But even that defect has its proper merits; for just as it is easier to appreciate the beauties of a small picture which can be seen at a single glance than a large one of which only a portion can be covered at one time by the eyes, so will it be found more easy to secure a general conspectus of the enormous resources, the inexhaustible variety and the illimitable extent of the British Empire by this small-scale reproduction of it than could be obtained by many years devoted to travel and exploration. That something must be missing is inevitable. We cannot reproduce in England either the spirit of the burning South or of the frozen North; we cannot in some few score acres hope to give more than a bare idea of the manners, customs and industries of the nations who honour the British flag, or of the lives of our own people who bear that flag in the uttermost corners of the globe. But what we can do, what the great Exhibition will unquestionably do, is to bring together those who inhabit the diverse nations and climes and show them, in some measure, what manner of life men live and what pursuits they follow in those portions of the globe that are unknown to them. Thus the Exhibition will become an educational medium of inestimable significance. It will broaden the minds of all those who visit it with open eyes, it will lead to a harmonising of diversities, it will enlarge sympathies and will knit the various members of the Empire into a more effective solidarity.

Such are the high ideals that we see behind the congeries of nations assembled at Wembley. But there is a more material aspect of the Exhibition. The value of sentiment—Empire sentiment, the sentiment that binds together all those that acknowledge the Mother Country—is not in question; but no empire ever has been, or ever will be, maintained on sentiment alone. Were sentiment sufficient in itself, America to this day would have remained part of the British Empire; we lost that great nation through interference with her commerce, and it may be held as a certainty that whilst in similar circumstances other nations would also declare and fight for their independence, it is equally certain that we may bind them together and to ourselves by the double bond of sentiment and trade. Hence it is very right that the Exhibition should be a vast fair as well as a panorama of the Empire. That British manufacturers should look upon it as an opportunity for proclaiming their wares and that they should found upon it their hopes for a recovery of their fallen trade is not to be wondered at; but there is not one of them who does not recognise that after all commerce is an exchange of commodities, and not of money alone. For what India, Canada, Australia or any other portion of the Empire buys from us, it pays, ultimately if not directly, in goods of its own production. Hence, the commerce which brings prosperity to Great Britain brings it equally to every one of the Dominions, Colonies and Dependencies. Whatever good may spring from the Exhibition, whatever encouragement it may give to flagging trade, will be shared by all. It is hoped earnestly that it will lead to an expansion of Imperial commerce, and that it will convince all the countries of the Empire that they can satisfy each other's needs and that by so doing they will gain mutual prosperity. It is hoped also that it will open before younger men and women the possibilities and attractions of foreign lands, and thereby lead to the increase of emigration to the Colonies and thus strengthen the bonds that tie her children to the Mother Country. It will fail, however, if it increases filial and neglects fraternal affection. It is no less important that the widespread countries of the Empire should become better known to each other than that they should augment their attachment to Great Britain, and we shall misun-

derstand the purpose of the Exhibition if we see in it only a means of displaying the wealth of the Empire to Britons and neglect to observe that, equally, it shows to every country, not only the wealth of Great Britain, but that of every one of the units of the Empire.

Such, we take to be the spirit of the Exhibition. Let us glance for a moment at the manner in which it has been embodied in those portions of Wembley with which engineers are principally interested. The position occupied by the numerous industries associated with engineering and shipbuilding in the United Kingdom is so great and is increasing at such a notable speed in several countries of the Empire, that especial provision has been made for the representation of those industries. The Palace of Engineering is the biggest single building in the Exhibition, and is only approached in area by the Palace of Industry, all the other pavilions being far smaller. In it are shown examples of nearly all the products of electrical, mechanical, marine and other branches of engineering to which the United Kingdom owes a great portion of its wealth. Regarded as a whole, the display is representative of the work of this country, but it is impossible not to feel regret that two important branches of mechanical engineering decided not to exhibit at Wembley. The machine tool trade of the kingdom has grown to such magnitude that its absence from the Palace of Engineering cannot fail to be commented upon with wonder. It should therefore be known as widely as possible that the machine tool makers will hold an Exhibition at Olympia during September, and that the makers of wood-working machines—the other trade to which we referred—will join them there. Thus not till the autumn will visitors to London have an opportunity for studying the full scope of British mechanical engineering. It is possible that technical visitors to the Palace of Engineering will find little that is new; as far as we have been able to ascertain by inquiries and by such inspections as were possible under the hurried conditions of the past few weeks, very few important new inventions or new designs will be shown. As engineers, that fact may cause some disappointment, but if we look at it from a larger aspect, our regrets may be tempered by the reflections that the machinery displayed represents types which have been tested by experience and not found wanting. We must constantly remember that the purpose of the Exhibition is to encourage trade, that in a very real sense it is a vast bazaar to which all the nations of the earth are invited to see the wares the Empire has to sell. In such circumstances, the proper thing for the "shopkeeper" to do is to show his stock wares in the "window," and that is just what British engineers are doing.

That it is a very remarkable display, we need not say. Exactly how many engineering firms are exhibiting, it is as yet not possible to ascertain, but that the Exhibition will give a finer and juster panorama of the engineering industries of the Empire than has ever before been presented, goes without saying. We trust sincerely that it may be the means of dispersing that gloom which has hung over the engineering and shipbuilding trades of this country for many months. It is the business of all who have the welfare of the Empire at heart to do all in their power for the achievement of that object, and it must be the particular duty of all of us who acknowledge Great Britain as our home to offer a warm welcome to those who come to us from overseas, whether they be foreigners or our own people, and to show them that British engineering stands to-day as high as ever. The time for criticism is past; the time for energetic action has come. The success of the Exhibition lies with the British people, and, above all, with British engineers. An unexampled opportunity for showing the world that British engineers, from whatever part of the globe they may come, are unsurpassed, lies before us. Let us take full advantage of it.

Communication Circuits.

Mr. S. G. Bartholemew's paper on "Power Circuit Interference with Telegraphs and Telephones," read at a recent meeting of the Institution of Electrical Engineers, shows that with the increasing use of electricity the problem of satisfactorily operating communication circuits is becoming a somewhat troublesome one. Those connected with the light current branch of electrical engineering have long been more or less bothered by interference from power circuits, and it is evident that unless proper precautions are taken these troubles will not diminish in the future. In his presidential address before the Institution of Electrical Engineers, Mr. F. Gill referred to this important matter. The two branches of the electrical industry, he said, must learn to work together harmoniously, and to avoid or mitigate the serious reactions which are liable to occur between their respective circuits. In grappling with the problem, there must not be any claim for priority or protection. The power engineer must not contend that the light current side of the industry must look after itself, nor must communication engineers assume that their existing arrangements are so perfect that they need not be altered. Mr. Bartholemew's paper covers a very wide field, and indicates how designers of electrical machinery and communication engineers may minimise interference. The importance of producing electrical machines free from harmonics is emphasised, for in that way, the author points out, practically the whole of the trouble associated with telephone circuits can be eliminated. The power engineer, it is explained, should design his systems so that the loads and lines are balanced. He should employ transformers working at low magnetic density and with connections that are least likely to cause interference, and he should endeavour to reduce the number of faults on his circuits. A part of the paper of particular interest at the present time is that which deals with interference from traction circuits. During the course of a discussion on rotary converters at a meeting of the Institution of Electrical Engineers in 1922, Mr. Bartholemew told those present that on the whole there was more trouble with direct current than there was with alternating current. In his paper, however, he seems to take the opposite view. This part of the paper, by the way, seems to be very largely a repetition of a part of another paper which the author read before the Institution of Post Office Electrical Engineers in 1914, and it contains statements which are not in conformity with present-day experiences, such, for instance, as the statement that arc lamps connected to the Dessau telegraph office wires on the Dessau Bitterfeld Railway were found to burn well. This story has been told over and over again by opponents of alternating-current traction, but as it refers to an early period in the history of single-phase railways, when much had to be learnt, there is no object, so far as we can see, in repeating it.

Another statement which, no doubt, will be made good use of by those who can see no field for alternating-current railways is that the cost of shifting the telephone lines from the Stockholm–Gothenburg railway will be £500,000. That is a lot of money, but the author should have stated what relation the figure bears to the total cost of electrification and the circumstances under which the lines are to be removed. As a matter of fact, we learn on very good authority that the contract for telephone cables for this railway was placed before it was decided whether the line should be electrified on the direct-current or alternating-current system. Continental engineers, it seems, contend that, as a rule, when long stretches of railways are electrified, the communication circuits should be removed in any case. Indeed, according to a recent article by Dr. S. P. Smith, the Germans consider that it is unsafe to run high-pressure conductors of any kind near communication circuits. Just recently we have received a communication relating to this matter from Dr. Behn-Eschenburg and Mr. Kristen, who consider that the disturbances which are most difficult to deal with, from a technical point of view, are those produced in electrical circuits by "transient phenomena." In the case of short circuits and interruptions on direct-current systems, the trouble is considered to be much more pronounced than it is in the case of the alternating-current systems, and the maximum induced pressure is not reduced by the use of quick-acting switches. When carrying out electrification schemes on a large scale, these authorities contend, it is scarcely possible to allow single-phase, three-phase, or direct-current traction wires to run parallel with the communication circuits, which should be placed underground. In Italy and Switzerland the use of cables for the telephone circuits has been resorted to on the most important sections, whereas in Sweden the trouble is being overcome partly by the use of cables and partly by other methods. The largest electric traction schemes, Dr. Behn-Eschenburg and Mr. Kristen point out, employ single-phase current, and similar experience with direct current is not available. The attitude of France with regard to this matter is somewhat difficult to understand, for although telephone interference on the experimental alternating-current line was completely overcome by taking apparently simple steps, the possibility of telephone interference was one of the reasons given for the final choice of direct current. Other reasons were, however, also given, and it is probable, we think, that the communication circuits really had little to do with the matter. It seems to us that the practice of converting the whole of the alternating traction current into direct-current for the sake of the telephones is a somewhat extraordinary procedure, especially if, as the Swiss and other continental engineers contend, the use of direct current will not remove the trouble. We note from the March issue of the *Journal* of the Institution of Electrical Engineers that a low musical note is already being heard in the telephones on the Midi Railway, but apparently it does not interfere with conversation. The work that has so far been carried out, however, constitutes but a small part of the complete undertaking, and it will be interesting to see to what extent the arguments of the Swiss and other continental engineers are correct. An interesting fact in connection with the French electrification scheme is that although direct current is now used for the propulsion of the trains, 60,000-volt transmission lines are supported on the same structures as the contact line and the inductive kick on the telephone circuits at times of short circuits apparently does not cause any appreciable inconvenience.

During the course of the discussion on Mr. Bartholemew's paper, Mr. R. A. Mack, of the Western Electric Company, explained that with proper telephone and telegraph equipment and installation there was no reason why there should be any interference from power circuits, and said that he knew of cases where communication wires ran parallel with single-phase lines. He also referred to the fact that with direct current electrolysis troubles had to be taken into account, and on the whole he doubted whether single-phase systems caused any more trouble than direct-current systems. Much depends upon the design and construction of the plant associated with power supply systems, and, according to Mr. Mack, in this respect continental engineers are ahead of British manufacturers. There is no doubt, we think, that this problem of eliminating interference is not such a terrible one as some suppose. At the present time cables are being largely used for telephone circuits, and their advantages were clearly set forth in a paper read some time ago before the Institution of Electrical Engineers by Sir William Noble. We do not wish to appear too revolutionary or too ambitious, but it seems reasonable to suppose that in time to come the bulk of the Post Office communication circuits will be placed underground. Possibly the carrier wave system may also help to solve the communication difficulty. The use of power lines for telephone purposes is a comparatively new development, but it is receiving a considerable amount of attention in America, whilst in this country Mr. Edmund Hann, of the Powell Duffryn Colliery Company, has adopted the system with marked success on the high-tension power lines between Llantrisant and Bargoed.

Literature.

Text-book of Industrial Cost Accounting. By P. M. Atkins, M.A. London: McGraw-Hill Publishing Company, Limited, 6 and 8, Bouverie-street, E.C. 4. 1924. Price 17s. 6d. net.

Although this work is primarily intended for the student of cost accounting, it is so written that it can be commended to engineers who wish to acquire a personal knowledge of the subject. The general problem is treated in a broad-minded spirit, the author realising that there can be no royal road to so intricate an investigation, and one that is complicated by such a variety of variables. His avowed intention is to fit the student for writing a satisfactory report upon the application of the principles of modern cost accounting to some manufacturing concern of which he has personal knowledge. We feel that the subject has been approached from the correct standpoint, which is that the cost accountant should always regard himself as the servant of the manager, being ready at all times to give information in whatever manner the management may desire.

The book naturally divides itself into eight main sections; the first, comprising six chapters, being in the nature of an introduction, in which the value of cost accounting and the various functions of an organisation are described. The next four sections, covering Chapters VII. to XXIV., deal with those main items which are responsible for the build-up of the cost, viz., material, labour, expenses and

burden. The next two sections consider the manner in which costs should be recorded, and the various aids to cost accounting, which include the different calculating machines, while the final section is devoted to a dissertation on the way in which cost records can be utilised.

In addition there is an appendix giving suggestions to the student as to the manner in which he should write the report to which allusion has already been made. A number of pertinent questions will be found at the end of each chapter, as well as frequent references to other works for additional reading.

The critic is somewhat disarmed in the face of such statements as "cost accounting will probably never be so well standardised as general accounting, because it is a record of transactions that necessarily vary greatly from industry to industry." We have in mind factories where cost accounting has not been the success it should, because the cost accountant did not possess that breadth of vision evidenced by Mr. Atkins, but rather tried to force a system which, though excellent for one form of product, was quite unsuitable for the case in point.

The idea of an organisation manual will be new to many, but the author strongly advocates it, suggesting that it should "set forth a definite conception of the work of the several departments," *i.e.*, it should give a clear lead as to the functions of each section, but not *how* they perform those functions. A good manual of this sort should certainly obviate all chance of the overlapping of duties which is so apparent in some concerns, but we cannot refrain from commenting on the elaborate staff required to work the system satisfactorily, as evidenced by the "organisation chart" on page 61.

The vexed question as to whether or not interest should be included as an element of cost is carefully considered, and, after setting out the *pros* and *cons*, the author does not favour inclusion, save in exceptional cases, as the additional cost of the records that have to be kept can hardly be justified.

On the subject of "burden," an American term defined as "the total of the manufacturing expenses, the load which the product or the business must carry," naturally a great deal has been written, and the necessity for discriminating between earned and unearned burden is emphasised. Obviously a shop foreman will discredit a system which shows his expenses rising when the volume of work passing through his hands is on the down grade, for he knows that he is consuming less power, and in all directions is having less service than before. Hence the need for dividing the burden and all the expenses paid which have rendered no service to the product should be treated as "unearned burden." In times of trade depression it may be necessary to maintain a nucleus staff, which will not be able to do very much in a directly productive way, and it is so obviously unfair to saddle the factory products with such charges that it would seem unnecessary to labour the point were it not for the fact that many cost accountants are not clear as to the treatment of the unearned portion, and so breed an atmosphere of suspicion in the minds of the factory administration. If we are satisfied as to the meaning of the burden, the question of the method of its distribution is a far more contentious one, for whereas a simple unit method would undoubtedly suit a factory turning out a standard article, it would be a lamentable failure in a more complex organisation whose products were varied and very dissimilar.

The method which the author appears to advocate is the machine-hour rate, in which every machine is rated at so much an hour, and each job charged with "factory overhead" to the number of hours spent by the different machines on the manufacture of the article. This method has been largely applied to industrial organisations in the United States, and it is for that country that the work under review is primarily intended; but we can say from experience that in the few concerns in this country where the machine-hour rate has been applied the results have been most encouraging, and in some cases a state of comparative chaos has been converted to one of intelligent system.

The author lays great stress on the value of cost accounts to the manager during the period of manufacture, but if the figures that are submitted by the cost accountant are to be of real service they must be available as soon after the completion of the article or component as is humanly possible. We should have been glad to hear from Mr. Atkins what he considers to be a reasonable time lag.

The only other omission from a book that is replete with information is some indication of what the cost of the cost accountant, his staff, his time recorders, computers and other machines is likely to be. Many engineers would welcome a cost accountant in their factories if they could form some conception in advance of what he was likely to cost and of what he was likely to save. They have visions of forms and cards *ad infinitum*, with a human army in their train, and they see their pay roll increasing without an adequate return being assured. If Mr. Atkins and other exponents of cost accounting would consider this suggestion and prepare a statement showing how specific commercial concerns had benefited financially by the application of the theories that are propounded in the modern treatises, they could nowadays make a very convincing case for themselves, better even than the argument, good though it undoubtedly is, that not one of those firms that have adopted the principle of cost accounting has eventually abandoned it.

The fact that this "Text-book of Industrial Cost Accounting" is written by an instructor in the University of Chicago for American students in no way detracts from its utility to the British engineer.

Low Temperature Carbonisation. By S. N. WELLINGTON, A.M.I.E.E., F.C.S., and W. R. COOPER, M.A., B.Sc. London: Charles Griffin and Co. 1924. Price 25s. net.

THE authors state in their preface to this book that while the subject of low temperature carbonisation has been the centre of many hopes and much discussion during the last few years, there has been no adequate treatment of it in book form. They have attempted, therefore, to fill a gap in the literature of the subject. In the present volume they discuss, in considerable detail, the various aspects of low temperature carbonisation, especially the character and value of the products, namely, the solid fuel, the gas, the ammonia, the tar and oils. Some experimental data that have not been published before, together with an analysis of the power aspects of low temperature carbonisation, are given, and an appendix containing the more important British patents closes the volume. The authors and publishers have done their work well, and have produced a very valuable and useful book on a subject that deserves the attention of all gas engineers. If this country is ever to be freed from the domestic smoke evil, it will probably be by the widely extended use of a solid fuel produced by the low temperature carbonisation process.

Chapter I. is introductory, and deals with Thomas Parker's first patent of 1906. We are pleased to see full justice done to Parker's original work, for there has been a tendency to ignore or discount his services in connection with the development of the low temperature process, and to blame him unjustly for the financial losses that occurred in the too hasty commercial exploitation of "Coalite." Parker's 1906 Patent Specification is reproduced at length in this chapter, and the authors state that, in their opinion, in this patent one finds the real solution of the low temperature process, provided the plant be constructed to carry out the details in accordance with the specification. Parker's invention, they add, was of great value, and although it is only recently that commercial success appears to have been obtained, that fact does not detract from the value of his early pioneer work in connection with the method.

Chapter II., upon the "Origin and Distribution of Coal," contains some useful preliminary facts and figures, and the study of the subject is really begun in Chapter III., which discusses the theory of the low temperature process and the laboratory results obtained by Wheeler and Burgess in their investigations of the volatile constituents of coal. Wheeler and Burgess's investigations were recorded in papers read before the Chemical Society in 1910–11, which are abstracted at considerable length. The authors state that these results "are of great interest and the re-examination of their (Wheeler and Burgess's) accurate investigations will afford a most useful study to those who desire to obtain a further insight into a very difficult problem. The authors have especially selected these results, as they bear the imprint of having been obtained with great care and skill and also with well-designed laboratory apparatus. Their low temperature results confirm in many respects those which have been obtained in low-temperature laboratories with similar coals."

Chapter IV. deals with some of the practical difficulties of low temperature distillation, and gives figures obtained with Dinnington main slack —7 cwt. charges—showing the slow transmission of heat to the centre of the charge in the retort during 7-hour heatings. The effect of temperature upon the yields of gas and tar are also discussed, and Vivian Lewes' experiments upon this point are cited. Chapter V. is entitled "The Relation of Thickness of Coal to Rate of Gas Evolution," and after analysing the figures available, the authors state that, "having regard to the foregoing, it is perfectly evident that the coal thickness must be kept down to about an average of 5in. when using low temperatures for the distillation of coal. Under certain conditions the thickness may be raised to 8in., and perhaps 10in., but in that case the method of heating must be altered materially."

Chapter VI. upon "The Products of Low Temperature Distillation of Coal" is one of the most valuable in the book, since in it the physical and chemical characteristics of the gas, tar, oils, and solid fuel are discussed at length, and the yields of ammonia sulphate from the high and low-temperature processes are compared.

Chapter VII., the longest in the book, describes and illustrates all the low-temperature systems that have been tried commercially. These the authors classify into three divisions, namely, those with external heating, those with internal heating, and those which utilise both. The only omission from this chapter is the Piron Caracristi process, which Mr. Henry Ford is reported to be exploiting in America. In this process a bath of molten lead is used as the heating agent for the fuel, which is sprinkled as a powder on its surface in a thin layer, and is then carried forward through the carbonising chamber by the flow of metal. This chapter is well illustrated, and in spite of this omission, is the best *résumé* of the practical side of low-temperature processes that we have seen.

Limits of space will not permit any detailed references to the remaining chapters of the volume, which deal with Research Results; the Coking Properties of Bituminous Coals; Recent Researches into the Structure and Behaviour of Coal under Heat and other Treatment; the Generation of Electric Power by various Systems on Capital Power Stations.

When a new edition is called for the authors might amplify the present index with advantage.

SIXTY YEARS AGO.

IN our issue of April 22nd, 1864, we reprinted from the *Telegraphic Journal* a short article by Mr. (Sir) W. H. Preece, entitled "The Application of Electricity to Domestic Purposes." We look in vain, however, for any sign that the author was among the prophets, for his vision of the uses to which electricity would be applied in the home did not extend beyond the electric bell. He extolled the simplicity, the certainty of action and the noiselessness of the electric bell, and urged that we should not lag behind the French in adopting it on an extensive scale for everyday domestic purposes. It may be doubted whether the electric bell of to-day always quite merits the praise heaped upon it by Mr. Preece, but compared with the vocal calls, the hand clapping, the hand bell, and that contorted system of wires, cranks and levers known as the bell pull which our ancestors employed for domestic signalling purposes, it is no doubt one of the minor improvements which the advent of the electrical age has given us. . . . In the same issue we published a report addressed by Mr. (Sir) Wm. Fairbairn to "Alderman Pochin and the gentlemen intending to purchase the Great Eastern steamship." The report was dated February 11th, 1864, and its appearance was somewhat belated, for just before it was published the vessel had been taken over by Glass, Elliott and Co. for the purpose of laying the Atlantic cable. Mr. Fairbairn expressed the opinion that she was admirably adapted for use as a cable ship, but his report was primarily concerned with the rehabilitation of the vessel as a passenger and cargo carrier for long voyages, such as to Calcutta. His chief recommendation was to the effect that the paddles and paddle engines should be removed and that the screws and screw engines—possibly speeded up—should alone be relied upon for propulsion. The speed, it was estimated, would by this plan be reduced from 14 to 10½ knots, but the net saving on coal and other items would, it was calculated, amount to over £29,000 a year. Mr. Fairbairn, however, suggested that with the reduced speed the difficulty already experienced of steering the vessel in a rough sea would be increased, and that it might be found necessary to supply her with new sets of masts, spars and rigging; in fact, virtually to convert her into a sailing vessel, with the screw engines as an auxiliary source of propulsion. We may perhaps, while referring to the Great Eastern, say that we have recently had recalled to us an interesting fact connected with her trial trip. A contributor of THE ENGINEER, the late Mr. Harrison, designed to supply us with a description of the event, and to that end shipped himself for the trial as a fireman. He was, however, discovered, and those in charge, determined to prevent unauthorised publicity, took the short but effective course of putting him overboard in an open boat, in which to make the best of his way ashore again.

Letters to the Editor.

(We do not hold ourselves responsible for the opinions of our correspondents.)

THE SPECIFIC HEAT OF GASEOUS MIXTURES.

SIR,—During the recent discussion at the Institution of Civil Engineers on "Efficiency Standards for Internal Combustion Engines," considerable stress was laid by various speakers upon the expressions for the specific heat of gaseous mixtures attributed to Stodola.

I do not think, however, that Stodola ever published these expressions as they stand. The figures given agree with those arrived at by me by a process of deduction from an article of Stodola's in the *Zeitschrift des Vereines Deutscher Ingenieure*, June 22nd, 1912, and which I used in an article on the "Limits of Gas Engine Efficiency" in *Engineering*, December 18th, 1914.

It seems probable that later writers who quote the specific heat formulæ as Stodola's have really obtained the figures, directly or indirectly, from the *Engineering* article. The degree in which they are due to Stodola is only limited, and is fully explained in that article.

The coefficients of the second and third terms are based on figures chosen as typical from among *several* values given by Stodola, and further, all the coefficients had to be converted into the form now quoted by means of an assumption as to the mean density of the probable typical mixture.

The formulæ in question have, no doubt, been regarded by the Committee on Heat Engine Trials and by others as having an authority to which they are not entitled.

I understand, though at present I have not been able to verify it, that Stodola subsequently has modified the specific heat values he used in 1912. In any case, it is important that the figures under consideration should be traced back to their original source before judgment upon their adoption or otherwise be pronounced.

Manchester, April 17th. T. B. MORLEY.

THE harbour at Ingonish, Cape Breton, is to be dredged to a depth of 21ft. in connection with the development of a local deposit of gypsum.

Institution of Naval Architects.

No. III.*

At the evening meeting on April 10th Mr. R. W. Allen presented a paper dealing with the "Application of Steam Turbines to Auxiliary Machinery," of which an abstract will be found on page 455.

Mr. James Weir said that Mr. Allen had proved the advantage of the turbine in respect of weight and space, and had shown that in the matter of steam consumption for auxiliaries the turbine was not at a disadvantage. When the whole of the factors concerned were taken into account, he believed that secondary advantages would decide the issue in favour of the turbine, and in the cases of the Berengaria and the Majestic, these had proved to be the case when the choice of turbines as against reciprocating engines was under consideration. One of the first installations of turbine-driven circulating pumps was on the Queen Elizabeth. The high figures for efficiency which had been quoted in connection with pumping installations were the result, he thought, of rather high overload. The weak point of the case for turbines for auxiliary machinery was their operation under port conditions. A balancing device to enable turbine plant to be run economically in port was needed. Mr. Weir concluded by exhibiting a rotary pump which had been in regular operation, and had dealt with 1,000,000 tons of water a year.

Mr. S. V. Goodall said that as a result of the Washington Treaty, those who were engaged in the design of warships to which displacement limits applied were investigating every method of saving weight and space. The advantages of turbine-driven auxiliaries, as outlined by Mr. Allen, were precisely those for which the warship designer was searching. Mr. Allen was not, however, definite enough. If he could add to his statement that by adopting the turbine drive for auxiliaries, overhauls, adjustments and renewals would be reduced, how much, for example, this saving would represent in space saved on the Hood for workshops, the naval constructor would be grateful. The designer of warships did not like having to provide workshops, and it was a farcical incident that during the war period one battle-cruiser was employing its workshop to make munitions for the Army. Turning to the subject of turbine-driven electric generating sets in H.M.S. Hood, the turbo-generator set weighed 9 tons less than a corresponding reciprocating engine set, but occupied a floor area of 50ft. more. The balance of advantage was in favour of the turbine, and in the Nelson and Rodney there would be no reciprocating electric generating sets. The turbo-generator was to be preferred to the Diesel engine set. An oil-driven generator compared with a turbo-generator of the same power involved a net increase of weight of 29 tons, an increase in the floor space required of 170ft., and in head room of 5ft. He did not agree with Mr. Allen as to the advantages of the turbine driven bilge pump, and an electrically driven bilge pump which would work under water had been developed and was preferred. He wished he could accept all the claims made for the turbine-driven boiler-room fan. This auxiliary was a great trial to the naval constructor, and the weight absorbed in support for the fan plant in the Nelson and Rodney had been a very sore point with the designer. An investigation made at the Admiralty into the proposed substitution of turbines for reciprocating engines for boiler-room fans indicated that the change would involve an increase in weight of machinery.

Mr. Allen, in his reply, expressed interest in the pump exhibit shown by Mr. Weir, which he regarded as a striking illustration of the advantage of turbine-driven auxiliaries. With geared turbines the steam consumption could, of course, be reduced. He personally believed there was a great future for turbine plant for auxiliary machinery in both war vessels and merchant ships.

A paper was then presented on "High Elastic Limit Mild Steel and its General Applications," the authors of which were Messrs. G. W. Barr, F. G. Martin and A. T. Wall. We reproduce this paper in full on page 443.

Dr. J. T. Milton welcomed the paper as an important contribution. His own view was that high elastic steel could be made as reliable as mild steel, but he thought it would be a great mistake if the impression got abroad, as might be imagined from the paper, that the steel which had been used up to the present time was defective, and that its elastic limit was only 8 tons.

Mr. T. M. Service was at a loss to understand what the authors were attempting to bring before the Institution, whether it was a new steel or one possessing properties which had hitherto been unknown. As the result of experiment, it had been proved that mild steel under severe shock was brittle, and in order to overcome this defect his firm has suggested to the Admiralty that they should supply material having a high limit of proportionality, and possessing greater toughness under these conditions. The Admiralty asked for a material as ductile as mild steel and having a limit of proportionality of 18 tons, and an order was placed for plates, channels and rivets. The material was manufactured by Messrs. Beardmore, and after exhaustive tests of its mechanical and physical properties was adopted by the Admiralty and placed on their schedule of steels. He would like to point out that steels having a high limit of proportionality only retained this property combined with moderate ductility if they were worked into the structure cold. If they were heated, their behaviour was altered. This problem of the alteration in properties by heating first arose in connection with rivets, but as the result of experiment, it was found possible to produce a steel which could be worked hot without the limit of proportionality being affected, and without its toughness being impaired, and the material was not like mild steel brittle under severe shock. The authors stated that their steel had an elastic limit of 16 to 17 tons per square inch, with an ultimate tensile strength of 30 to 35 tons per square inch. His experience led him to the conclusion that it was not commercially possible to produce steel with that elastic limit. Tests carried out at the National Physical Laboratory with the steel which could only be worked cold showed a limit of proportionality of 23.1 tons per square inch and an ultimate tensile strength of 37.3 tons. Nor was it in accordance with his experience, as stated by the authors, that the modulus of elasticity was increased by 8 per cent. The steel which he had described and which was produced by his firm for Admiralty purposes had, as he had indicated, a high limit of proportionality, but users would be well advised to hesitate before accepting claims for increased modulus or a fatigue limit approaching the limit of proportionality. It would seem that the authors had had no actual experience with the steel they described, or they would know that the material could not be welded and retain its property.

Mr. W. J. Berry (Director of Naval Construction), in a written contribution, suggested that the authors had paid so much attention to the question of elastic limit that they had failed to recognise that it was only one of many properties possessed by steel, all of which were of importance to the designer. For some requirements, the fatigue of the material must be the criterion, and the connection, if any, between fatigue limit and elastic limit had not at present been elucidated, although experiments seemed to indicate that there was very little correspondence between the two. For other purposes the designer cared neither about the fatigue or elastic limits, but desired to know the energy-absorbing quality of the steel, and for still other requirements the yield point assumed chief importance. There was indeed only a very narrow field of service within which the designer would be governed in his choice of material solely by the elastic limit he was able to obtain. The problems to be faced in warship design were in many respects quite different and distinct from those encountered by designers of merchant ships. The Admiralty was one of the largest users of steel in the country, and it was therefore a matter of surprise that neither the Admiralty staff nor any of the Admiralty overseers —forty of whom were on duty in various parts of the country—had seen any of the steel having this high elastic limit, which was the development of one of the authors of the paper. Nor as far as he could ascertain had any steel manufacturers seen this material. The Admiralty, which had been using for parts of the hulls of warships steels of much greater strength than ordinary mild steel, had given a great deal of attention to the subject of elastic limit, and had had about 10,000 tons of steel plates, sections and rivets made to a specification embodying an elastic limit higher than that mentioned by the authors. At the present time the Admiralty were using five separate steels, all stronger than mild steel, three of which had been in constant use for the last fifteen years. The mildest of these steels had an ultimate strength of 30 to 34 tons in the annealed condition. The elongation and other general characteristics were those of mild steel, and no samples actually tested had shown an elastic limit lower than 14, the average being about 16. A member of the construction branch of the Admiralty was told recently that Mr. Martin had been negotiating with a certain firm to make 3000 tons of steel with a tensile limit of 28–35, and a limit of proportionality of 15, and that this was as far as the manufacture of this steel had gone. These figures were comparable with those of Admiralty steel (H.S.D.), and it might be news to the authors of the paper that all submarines for the last eight or ten years had been constructed of this particular steel. When Mr. Martin last approached the Admiralty, he was asked to state the total quantity of steel plates which had been rolled, if he would give the chemical composition and the mechanical qualities of his material, and particulars of the treatment during manufacture. It seemed to him that before any useful discussion could be made on Mr. Martin's steel, this information must be forthcoming. It was well known that the Admiralty had recently introduced a steel with a limit of proportionality higher than that claimed by Mr. Martin for his steel, while plates made to that specification had all the qualities of working and elongation of slightly hard mild steel. This steel was actually being used in very large quantities at the present moment, and no difficulties had been experienced.

Dr. Montgomerie said that the authors had raised a most interesting point in focussing attention on the effects which should follow an improvement in the standard of efficiency of the materials used in shipbuilding. No attempt was, however, made in the paper to supply details with regard to actual reductions in scantlings that would be possible on the assumption that increased efficiency of material had been obtained. Designers had always wished to have at their command a material which would justify a substantial reduction in the weight of steel used in merchant ship construction. The question had, however, always resolved itself into an economic problem, and this had made it necessary to adhere to the use of ordinary mild steel. One of the first questions that should be put to the producer of the new material must relate to its ductile properties and its capacity for withstanding stresses which varied between wide limits. In that connection, two statements in the paper were worthy of attention. One was that the new steel had an elastic limit of 16 to 17 tons per square inch, and that its ductility was as good as that of ordinary mild steel. It was a little difficult in the light of experience to correlate the figures for elastic limit with those for ultimate strength. If the ultimate strength had ranged from 35 to 40 tons or from 37 to 47 tons per square inch, an elastic limit figure of 16 to 17 tons per square inch would be regarded as normal. But with a range of ultimate tensile strength of from 30 to 35 tons per square inch, the figures given by the authors for elastic limit were outside experience. With regard to ductility, it should not be forgotten that while 20 per cent. elongation on a length of 8in. might be a legitimate minimum figure for a certain thickness of material, it did not in itself make the ductility of the proposed steel as great as that of ordinary mild steel. It was a little surprising to read that the modulus of elasticity of the new steel was about 8 per cent. greater than that of ordinary mild steel, as it had long been accepted that all steels had approximately the same modulus, and in any case the difference of 8 per cent. was a matter of variation between different samples. He preferred to suspend judgment on those points. It was also stated that if the riveted joints of the elastic steel were made in accordance with the practice for ordinary mild steel, there would be no increase in the elastic slip value of the riveted joints, whereas it should be increased to be commensurate with the increased stresses of the elastic steel. He was not satisfied that any additional riveting could logically be demanded, as although the stress was doubtless greater, it was exerted on a smaller area, and the total force might be the same. He deprecated very strongly the proposal to weld the butts electrically. Had the authors considered the effect of heating on the material in the vicinity of the weld? Another point was the provision of sufficient rigidity to provide against failure by secondary flexure. It would not be right to take account of any increase in the modulus of the material. There was sufficient evidence derived from actual practice to prove that even relatively thin ship plates could effectively transmit compressive stresses. The value of the elastic limit in compression was important, but no reference was made to it in the paper. If the elastic properties claimed for the material could be demonstrated and the standard of construction raised, it would seem that a case had been made out for some reduction of scantlings.

Mr. W. Simons agreed that tensile strength was not the only factor of importance in shipbuilding construction, but that the elastic limit to which sufficient attention had not yet been given, was perhaps of even more importance. He thought the authors had made suggestions that called for the consideration of those responsible for ship designs. The point, however, was not a new one, as it had engaged the attention of the Admiralty for many years, and, as Mr. Berry had pointed out, steel for fulfilling all the conditions claimed for the authors' steel had been manufactured for the Admiralty for fifteen years. During the last few weeks a further quantity had been delivered and tested with satisfactory results, the ultimate tensile strength ranging from 33.6 to 33.75 tons, yield point 21.2 to 22.45 tons, and elastic limit 18.2 to 21.15 tons. The only difference in practice during recent years in connection with that steel was that an extensometer test has been specified. He had before him the whole series of tests taken by the Ewing extensometer, which proved quite clearly that the value of the elastic limit in steel had been recognised by the Admiralty before the authors came into the field.

Mr. F. G. Martin, in replying to the discussion, suggested that the Admiralty scouts in their tours round the shipyards had not done their work properly, as there were works in which the new steel was being manufactured. There was no more difficulty in working heat-treated steel than in working cold steel. Important experiments were now being conducted with the new material, and it was to be employed for the building of merchant ships.

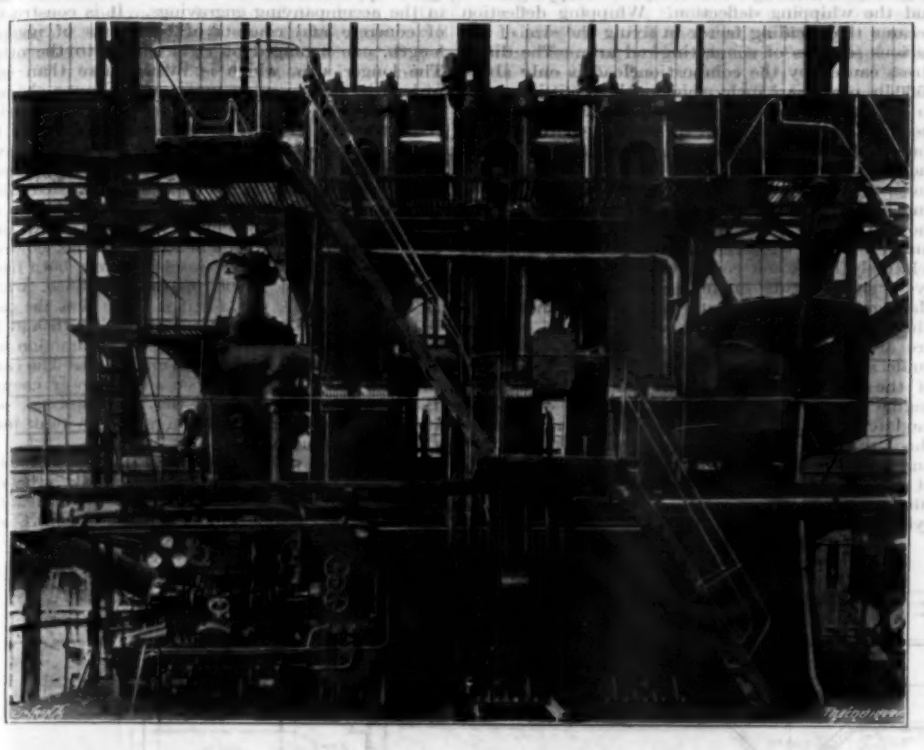
Mr. A. T. Wall said that it was worth noting that Sir Eustace d'Eyncourt gave Mr. Martin credit for the introduction of this steel.

* No. II. appeared April 18th.

It was stated in our Journal page on the 18th inst. that the Garratt locomotive, ordered by the London and North-Eastern Railway, is for use on the Worsborough branch. This line runs from the Barnsley–Mexborough line of the Great Central to the Penistone–Barnsley line. It is 7 miles long and has gradients as severe as 1 in 39 and 1 in 45.

2000 B.H.P. MARINE OIL ENGINE

NORTH BRITISH DIESEL ENGINE WORKS, LIMITED, GLASGOW, ENGINEERS



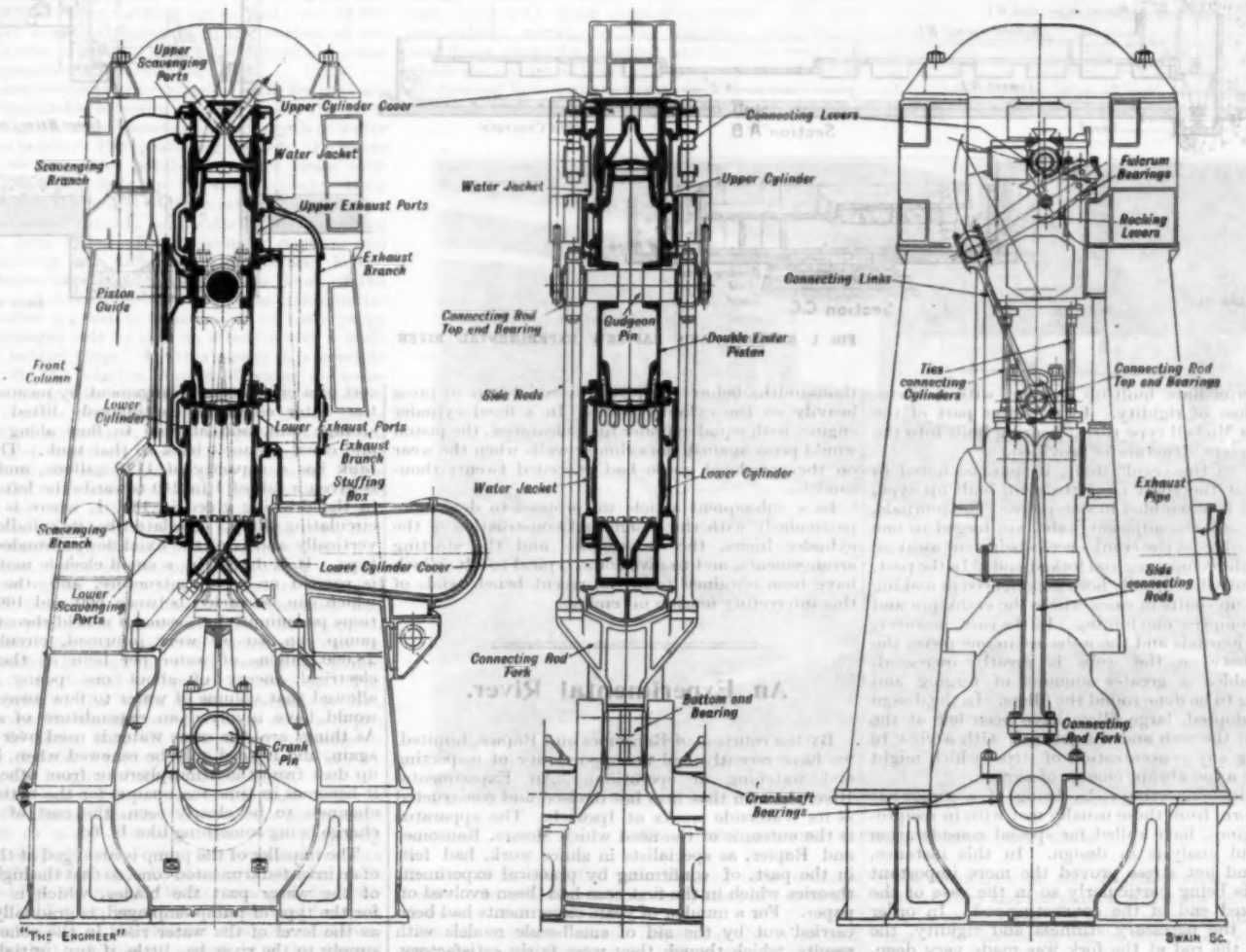
A Sliding Cylinder Two-cycle Double-acting Marine Oil Engine.

No. I.

AT various times we have made reference in these columns to a new two-cycle double-acting marine oil engine which has been designed and built at the North British Diesel Engine Works, Limited, Whiteinch, Glasgow. Although completed last year, the intervening period has wisely been spent in carrying out careful trials, which culminated in a series of demonstration trials which were concluded some days ago. On Tuesday, the 15th inst., Mr. J. C. M. Maclagan, to whose inventive ability many of the new features of the engine are due, gave a paper before the Institution of Engineers and Shipbuilders in Scotland, in which the engine and the various problems which have arisen during the period of its design and construction, are described. The paper referred to is very complete, and it gives in detail a great deal of the experimental work which has been done during the development stages, with accompanying tables and curves. Further particulars are also included of the installation of this first large unit on the cargo steamer Swanley, built for Harris and Dixon, of London, by Barclay, Curle and Co., Limited, of Glasgow, which vessel is now fitting out at Whiteinch. Trials of this ship will, it is expected, take place shortly, and we then hope to give an account of the ship and its performance. In the present article references will be made more particularly to the working principle of the engine and some of the details of its construction.

The drawings which we reproduce below are partly diagrammatic, but they will serve to indicate the working principle. A view of the engine on the test bed is also given. The leading particulars are as follows:—Total designed output, 2000 brake horse-power; revolutions per minute, 100; number of lines of cylinders, three; diameter of cylinders, 22½in.; stroke of piston, 44in. Referring to the drawing, it is to be noted that three sectional views are given. That to the left hand is an athwartship section through the engine; the centre view a longitudinal section; and the right-hand view a further athwartship section showing an external view of one engine. From these illustrations, it will be seen that each cylinder line comprises an upper and a lower cylinder, both of which are open at either end. The cylinders, together with their respective water jackets and the attached scavenge air and exhaust branches, are free to reciprocate relatively to the two cylinder covers, which are provided at the outer ends of the cylinders. These covers are made in the form of stationary pistons, and are furnished with spring piston rings, in order to ensure gas-tightness. The upper and the lower cylinders are connected to each other by two ties placed diametrically opposite to each other. Between the covers and inside the cylinders there is a double-ended piston with a gudgeon pin having extended ends passing out between the upper and the lower pistons, sufficient space between the cylinders being left to accommodate the movement of the piston. At each end of the extended gudgeon pin there are journals provided, which take the top end bearings of the main connecting-rod. Side connecting-rods extent downwards from the top end bearings, and at their lower ends are attached to the connecting-rod fork. The connecting-rod fork carries a crank pin bearing of usual construction, and crank shaft bearings on either side of the crank web support the main crank shaft. The middle of the piston is furnished with a slipper guide, having ample bearing surfaces, which is supported on one side of the main columns.

The two cylinders, along with their respective water jackets, scavenging and exhaust branches, are caused to reciprocate by the link gear illustrated in the drawing above. Connecting links are attached at their lower ends to the extended portions of the main gudgeon pins, and at their upper ends to journals



SECTIONS THROUGH TWO-CYCLE SLIDING CYLINDER MARINE OIL ENGINE

provided at the extreme ends of the cylinder operating levers. Actually, the cylinders are given a reciprocating motion by means of further links attached to intermediate points on the rocking levers. These turn about fulcrum bearings, and the gear is so designed that the main cylinders, together with their water jackets, reciprocate synchronously with the main piston, but through a much smaller distance. Thus the scavenging ports provided at the outer ends of the cylinders are uncovered by the relative movement of the cylinders to the cylinder covers, while the exhaust ports, which are arranged at the inner ends of the cylinders, are uncovered by the relative movement of the piston to the cylinders. The front column of the engine is made hollow, and serves as a scavenge air reservoir, it being furnished with appropriately designed stuffing-boxes to accommodate the sliding scavenging air branches. In a similar way, the exhaust manifold has a stuffing-box to take the sliding exhaust branch.

Having given a brief account of the essential parts of the engine, it may be of interest to describe some of these parts in detail, since the very original character of the engine has necessitated departures from standard marine practice.

The main bed-plate does not call for special comment. It is of the ordinary box-section type, and is made in two parts, with intermediate cross girders, which form the housings of the main crank shaft bearings. The underside of the bed-plate is quite flat, which allows it to be bolted down directly on to the inner bottom of the ship without having recourse to an intermediate built-up seating, with a corresponding loss of rigidity. In the after part of the bed-plate a Michell type thrust bearing built into the main bed-plate structure is provided.

Turning to the crank shaft, it may be noted in passing that the shaft is of the semi-built-up type, and that it is assembled in one piece. The journals, or journal and the adjacent webs, are forged in one piece, the edges of the crank cheeks being cut away so as to clear the connecting-rod forked-ends. In the past, some difficulty has usually been experienced in making semi-built-up shafts in cases where the crank pin and the webs comprise one forging. In the case, however, where the journals and the webs are in one piece, the distance between the webs is greatly increased, which enables a greater amount of forging and hammering to be done round the fillets. In the design of shaft adopted, large fillets have been left at the junction of the web and the journal, with a view to eliminating any concentration of stress which might occur with a too abrupt change of section.

The main connecting-rods, being of a somewhat different form from those usually met with in reciprocating engines, have called for special consideration and careful analysis in design. In this instance, rigidity and not stress proved the more important factor, this being particularly so in the case of the lower forked end of the connecting-rod. In order to obtain the necessary stiffness and rigidity, the section of the rod at the fork was made very deep. From the calculations made, it was found that the combined tension and shear stress caused by the combustion load was very low, not more than about 2000 lb. per square inch for the down stroke and 1802 lb. per square inch for the up stroke. These stresses made it possible to utilise cast steel as a material with safety.

Owing to the abnormally high length ratio of the connecting-rod to the crank, which is 8 to 1, it became necessary to investigate carefully the whipping stress and the whipping deflection. Whipping deflection became the deciding factor in fixing the size of the various sections of connecting-rod arm. The direct stress caused by the combustion load is only about 2560 lb. per square inch, which, although it is subject to a partial reversal, is a very low stress for forged steel. The whipping stress, on the contrary, was found to be in the neighbourhood of 4050 lb. per square inch. It is probable that in the case of the engine under review, these parts are unduly heavy, but we understand that the sizes may be revised later, when more experience has been gained. The bearing pressures for the two-cycle double-acting engine are relatively low when compared with a typical four-cycle single-acting engine, and in his paper Mr. Maclagan gives some interesting curves and figures illustrating the points we have referred to. Curves are also given showing the reaction on the piston guide slippers, which is correspondingly low. One of the interesting features of the sliding cylinder engine which the makers claim, is that it will accommodate itself more readily to wear than will the guide shoes of any other type of engine. Thus, with a uniform diametrical clearance of twenty-thousandths of an inch between the piston and the cylinder, and a similar clearance between the cylinder cover and the cylinder, the guide shoe would require to wear forty-thousandths before the piston would begin to press heavily on the cylinder walls. In a fixed cylinder engine, with equal cylinder liner clearance, the piston would press against the cylinder walls when the wear on the crosshead guide had exceeded twenty-thousandths.

In a subsequent article we propose to deal more particularly with the design and construction of the cylinder liners, the valve gear and the starting arrangements, and to give some typical results which have been obtained from the recent bench trials of this interesting marine oil engine.

An Experimental River.

By the courtesy of Ransomes and Rapier, Limited, we have recently had an opportunity of inspecting and watching in operation, "An Experimental River" which that firm has devised and constructed at its Waterside works at Ipswich. The apparatus is the outcome of the need which Messrs. Ransomes and Rapier, as specialists in sluice work, had felt, in the past, of confirming by practical experiment theories which in the first case had been evolved on paper. For a number of years experiments had been carried out by the aid of small-scale models with results, which though they were fairly satisfactory, were until recently regarded as being rather more amusing than actually instructive, and a good deal of water was used in performing them. Eventually, however, it was decided to construct a comparatively large scale model of a river, with a branch leading from it which might be made to represent, say, an irrigation canal take-off, the arrangements being such that the water could be used over and over again.

The apparatus which was evolved is well illustrated in the accompanying engravings. It is constructed of concrete and consists of two arms of unequal length, one arranged at right angles to the other. The longer arm, which is rather more than 40ft. in length, comprises an upper and a lower channel, the former of which is the "river" proper, while the latter is simply a storage tank into which the water flowing along the river bed can fall. As will be seen from the drawing given in Fig. 1, the sides or banks of the river are not parallel for their whole length, widening out as they do from 2ft. 4in. to 4ft. The reason for this difference in width will be explained in due course. For 14ft. near the middle, however, the banks are parallel, or would be were both banks complete for the whole of that distance, which, as a fact, they are not, for it is there that the canal branches off. The canal is 12ft. in length and 2ft. wide inside its banks, excepting at its junction with the river, where it is widened out to 4ft. The canal, like the river, has an upper and a lower channel, the latter forming part of the main storage, since it is in direct communication with the tank under the river channel.

One of the points which the designers kept in view was, as has been intimated above, the conservation of water, and it was at an early stage decided that the best thing would be to have some sort of a circulating arrangement by means of which the water could be continuously lifted from the storage tank and allowed to flow along the river and canal channels back to that tank. The storage tank has a capacity of 1125 gallons, and its floor is given a fall of 1 in 240 towards the left-hand end in the drawing given in Fig. 1, where is fixed the circulating pump. The latter has its spindle arranged vertically and is of the axial-flow, shrouded-impeller type. It is driven by a small electric motor, which is carried on a superstructure, and the speed of which can be varied between 600 and 1000 revolutions per minute by means of a field rheostat. This pump can, so we were informed, circulate some 28,000 gallons of water per hour at the cost for electrical energy of about one penny. To have allowed that volume of water to flow away to waste would have involved an expenditure of some 35s. As things are, the same water is used over and over again, and it need only be renewed when, by taking up dust from the atmosphere or from other sources, it becomes in time too opaque for the bottom of the channels to be clearly seen, the cost of the fresh charge being something like 1s. 6d.

The impeller of the pump is arranged at the bottom of an inverted truncated cone, so that the high velocity of the water past the blades, which is necessary for the type of pump employed, is gradually reduced as the level of the water rises in the cone, and the supply to the river has little, if any, initial velocity. The chamber immediately below the impeller is made basin-shaped and has a cone of concrete rising in its centre, the cone being so shaped as to provide a more or less stream line approach of water to the pump, which, as it is fixed in the chamber well below

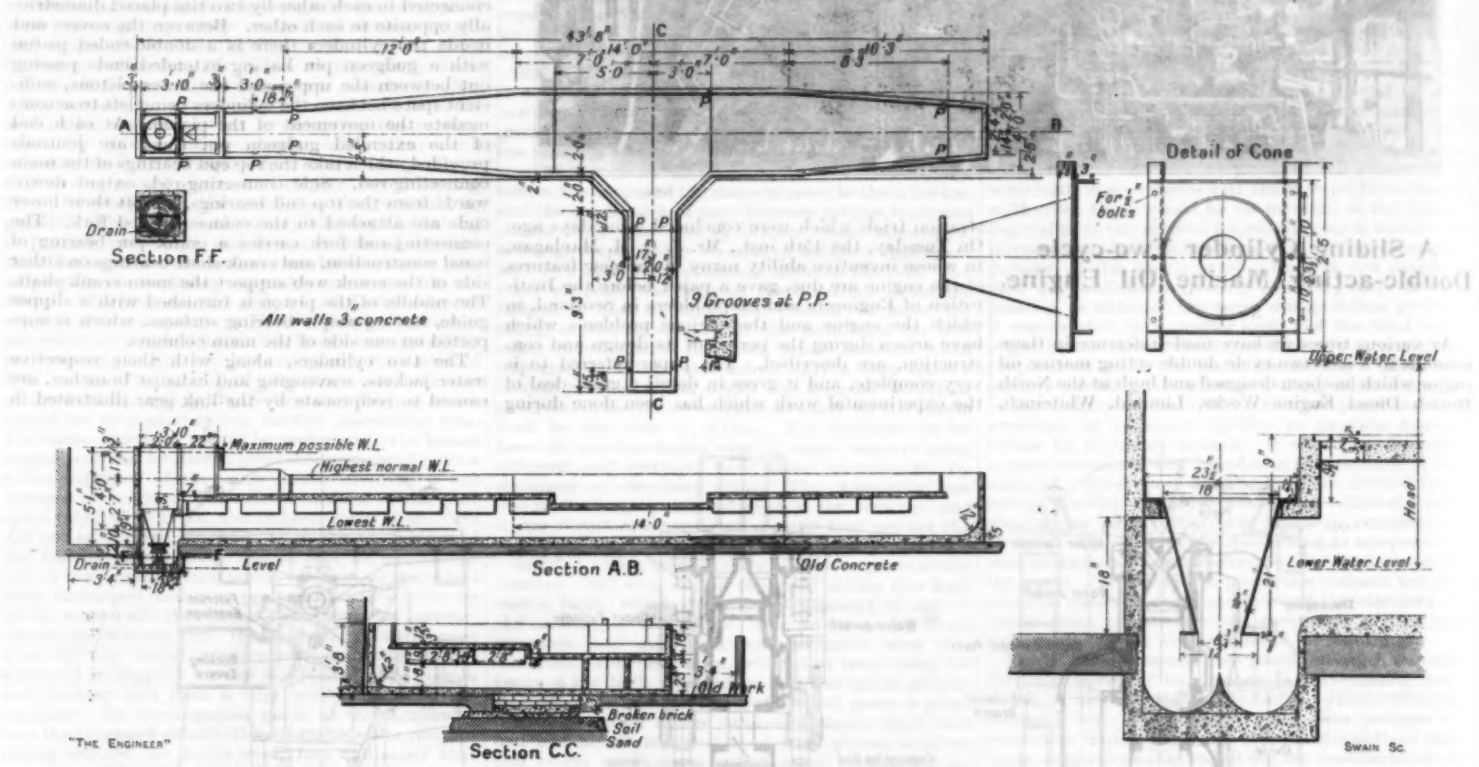


FIG. 1—RANSOME AND RAPIER'S EXPERIMENTAL RIVER

the level of the floor of the storage tank, is always effectively drowned even when the tank is nearly empty. So as to prevent "swirl" in the direction of rotation of the blades, boards are arranged vertically and fitted closely to the outsides of the truncated cone and to the bottom of the basin. The placing of these boards is said to have improved the efficiency of the pump by as much as 60 per cent. The ability to vary the speed of the motor, taken in conjunction with a by-pass of triangular

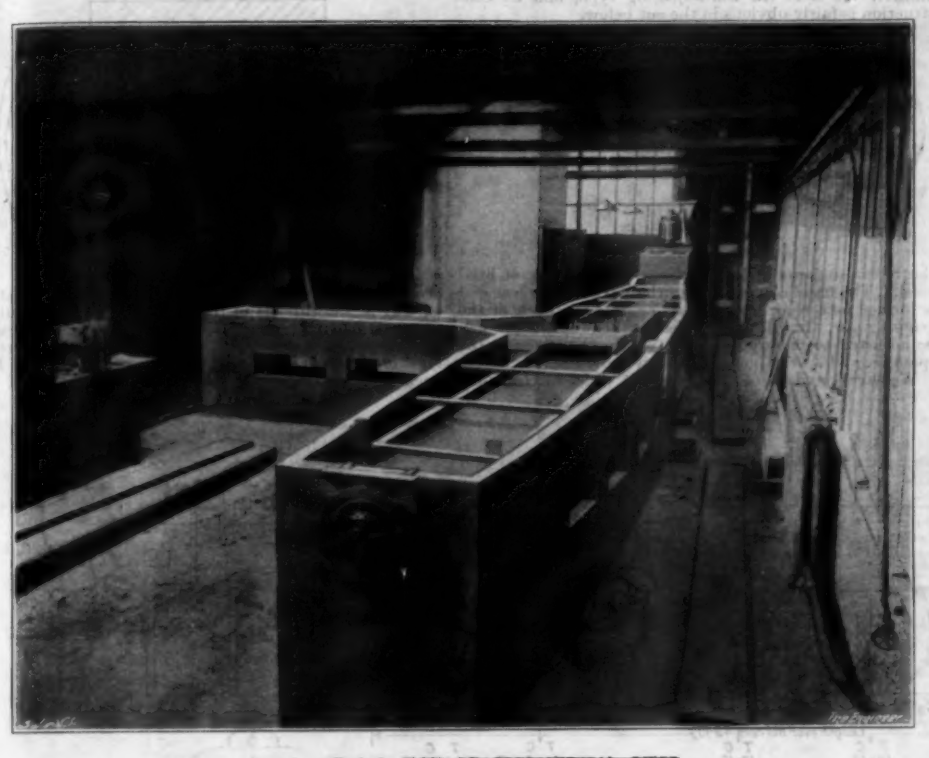


FIG. 2—GENERAL VIEW OF EXPERIMENTAL RIVER

shape, which is fixed near the outlet from the cone, enables the flow of water to be readily and finely controlled, the range being from 0 to 1.25 cubic feet per second, or from nothing up to just over 28,000 gallons per hour. Opening from the bottom of the pump chamber is a large drain by which all the water in the apparatus can be emptied away.

There are complete arrangements both for measuring the quantities of water passing down the river and canal and also for ascertaining the depth of water at various points. For measuring the flow, the water is made to pass over notches of sheet brass with bevelled edges as it falls into the storage tank. Both the width and the height of the crest of these notches can be adjusted quickly and without discontinuing the flow over them. For measuring depths, and hence arriving at differences in surface levels, various holes have been formed in the floors of the channels, and, from pipes let into these holes, india-rubber tubes are led to a series of vertical gauge glasses arranged side by side on a board with a scale mounted behind them. By this means it is possible to read off the relative depths of water at some dozen points in the channels without the observer having to move about from place to place. There is the added advantage, since the gauge glasses are all arranged together, that the readings can be taken practically simultaneously by one man. This gauge board and also the field rheostat are made portable, so that alterations in rate of flow and observations of depth, &c., can be made from any position which happens to be most convenient.

With the object of damping out waves or turbulence set up by the pump, grooves are arranged at various points in the sides of the channels and into them perforated zinc baffles can be dropped. With them, practically all the turbulence can be obliterated by the time the water reaches the points at which it is desired to make observations. The actual height of the walls of the channels is 1ft., but the experiments are usually made with a depth of water of about 10in. It is, however, possible to have any desired depth up to just under 12in., by adjusting the heights of the overflow weirs.

Attention was drawn above to the fact that the walls of the channel forming the river are not parallel from end to end. The apparatus was purposely given the shape it has, so that temporary alterations in the width and shape of the river might be made as desired by means of planks arranged on their edges and held down by cross stays wedged between the concrete sides of the channel, the joints between the bottoms of the planks and the floor of the channel being made water-tight with putty. The enlargement of the end of the canal where it joins the river was also made so that different shapes of sluices and diversion weirs might be experimented with. Moreover, the floor of the river channel is stepped down just opposite the canal take-off with the object of testing river beds of any type and shape with the aid of models made to fit into the space left. Piers of any desired shape can also be anchored in the channel at any required points. The half-tone engravings—Figs. 2 and 3—show the apparatus fitted for testing diversion sluices and piers of special types; and it will be seen that only a portion of the total width of the river bed is being used.

As can well be imagined, the whole design is such that it is possible to test a practically infinite number of different arrangements, and, as a fact, special forms of channel sluices, piers, &c., have already been tried with most interesting results. We were particularly struck by the rapidity with which conditions could be changed and by the ease with which the results of those changes could be observed. As showing how quickly things can be done, we may say that the 40ft. or so length of river channel, 2ft. 4in. wide, was filled to a depth of 10in. in under 1 minute from the switching on of the current to the motor.

On the occasion of our inspection the river and canal had been fitted up to test a certain arrangement of Walton sluices, and it was particularly instructive to watch the behaviour of the water with differing rates of flow and depth. There are various means of studying what goes on under steady or varying conditions. Thin pieces of paper or chips of wood thrown on the surface of the water readily show the direction and rate of surface flow, and it was interesting to note that in certain circumstances the direction of flow of the surface water on the discharge side of sluices of a certain form was up-stream and not down-stream. For observing the direction and rate of flow at various levels below the surface thin streams of coloured liquid, which does not readily become diffused in the main flow of water, are employed. By this means some most interesting observations have been made regarding the behaviour of water when it flows from a river into a canal, and the differences brought about by altering the shapes of piers, sluices, weirs, &c. Already some very valuable data have been arrived at, and since the results obtained are being collated and analysed in a scientific manner, results of really practical importance have been reached.

Not by any means the least attractive of the experiments which we saw made was that in connection with silting. The "silt" employed was fine saw-dust which, by being soaked in water, had become waterlogged, so that, when in still water, the tendency was for it to sink to the bottom, whereas in water moving with quite a low velocity it was carried along with the liquid. It was perfectly easy to observe the different points in the system where silting tended to commence, and where there was no silting at all, and it was of considerable interest to note what great changes in the tendency to silt were brought about by exceedingly small changes in conditions. It struck us that, in this direction alone, results of far-reaching importance are likely to be reached with the model.

Another direction in which the model has already proved itself useful is in showing the comparative merits of different forms of sluice construction. We witnessed a test made of a roller chamber of the ordinary type side by side with a chamber of new design. It is well known that in certain conditions there is excessive chattering of the lines of rollers when housed in chambers of ordinary form, this chattering being set up by reason of turbulence of the water in the chamber. In the new design of chamber the aperture by which the water can find its way into the interior is very greatly constricted, so as only to be a narrow vertical slot; whereas, in the older type, there is a much larger opening, so that the water rushing past the opening occasions very considerable eddies and turbulence. Models of the two forms of chamber when arranged in position in the "river" showed conclusively the superiority of the new type, for in it turbulence was conspicuous by its absence. This result had, of course, been anticipated when the design was got out, but it was satisfactory to see theory borne out in practice, and Messrs. Ransomes and Rapier have every confidence that the new invention, which, by the way, is patented, will introduce a considerable improvement into culvert sluice construction and effect a welcome reduction in upkeep costs. With

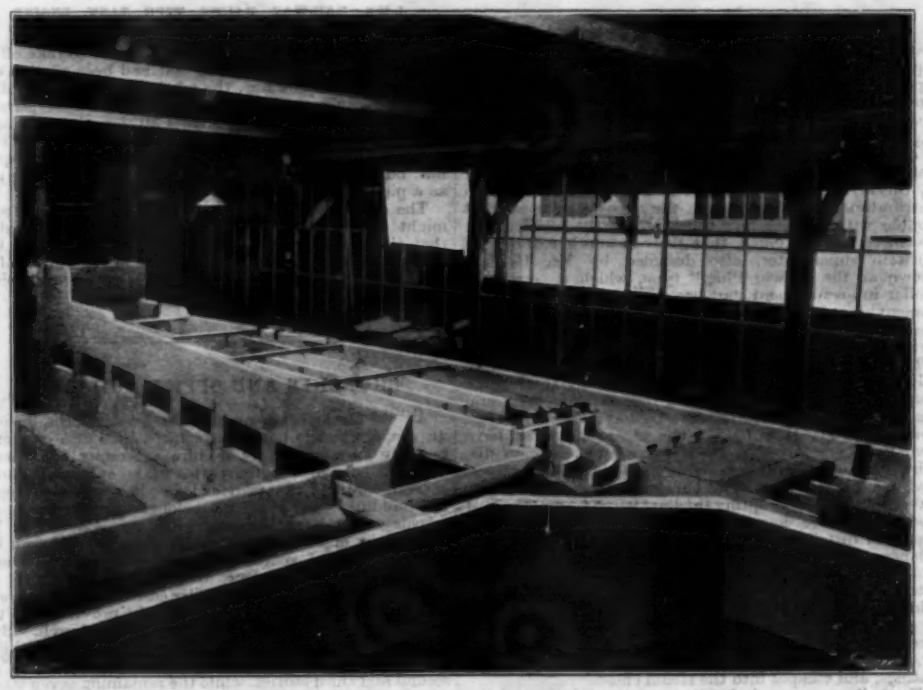


FIG. 3—VIEW SHOWING CENTRAL PORTION AND CANAL

roller chambers of the ordinary type, the bushes of the rollers and the pins on which the rollers revolve are, in many cases, seriously worn in quite a short time. If chattering can be eliminated wear should be very largely diminished.

A question which naturally arises when considering a model of this kind is, how far is it possible to say that results obtained with it will be reproduced in full size structures? That, of course, only actual experience can positively decide, but we gather

that, so far as matters have gone at present, everything seems to point to the fact that experimental results will be reproduced very closely in practice. If that be found to be so, the model should undoubtedly have a wide field of usefulness open to it.

L.M.S. Railway 4-6-4 "Baltic" Tank Engines.

The engines, one of which is illustrated below, are intended to be used for heavy suburban traffic over severely graded lines where great accelerative power in needed, but at the same time they may be called upon to haul express "residential" trains up to about 50 miles radius so as to release 4–6–0 tender engines from that service for main line work.

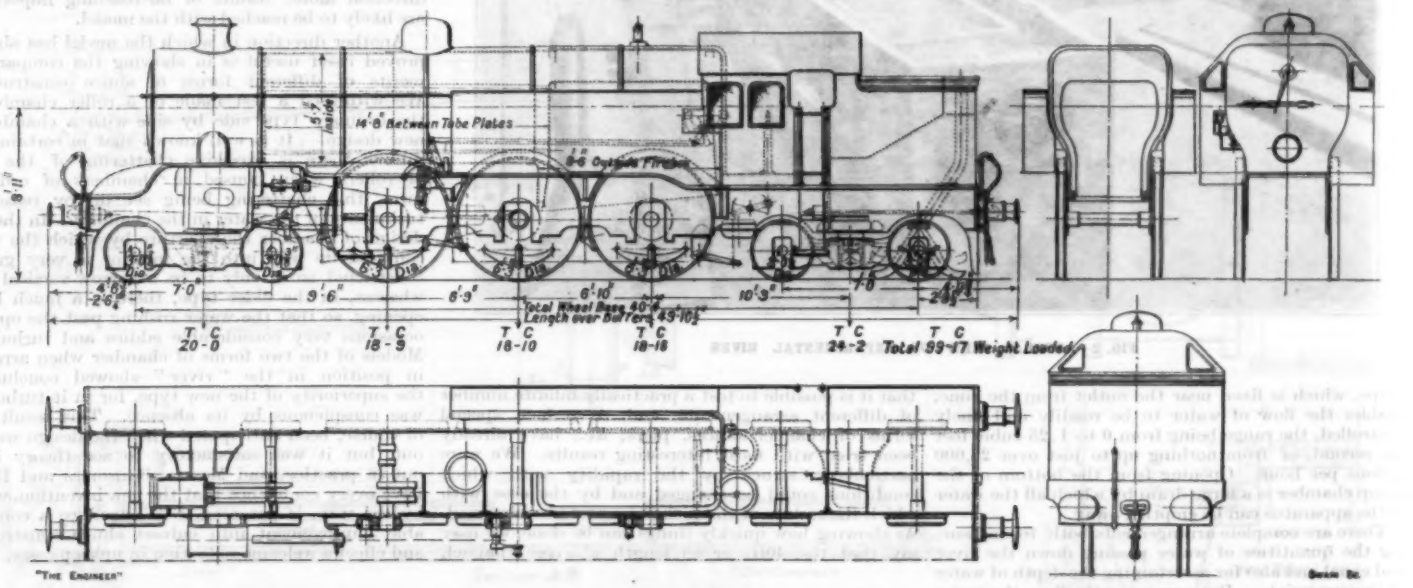
The Horwich-built four-cylinder superheated 4–6–0's with 6ft. 3in. wheels have proved themselves over an extended period to combine the capabilities outlined above with economy in running and upkeep expenses, so that in producing the tank engine as little departure as possible has been made from the design of these 4–6–0's. The frames have been lengthened at the rear to take the bunker and trailing bogie, the wheel base has been lengthened somewhat to comply with permanent way restrictions, and the grate area of the fire-box has been increased from 27 to 29.6 square feet.

The superheater employed is the "Horwich" design, commonly known as the "Top and Bottom" header superheater, designed by Mr. Hughes. In it the elements are placed in a vertical position down each side of the boiler instead of horizontally as in most other types. Separate cast iron headers are used for the saturated and superheated steam, those for the latter being bolted directly on to the cylinder castings, thus doing away entirely with intermediate steam pipes, and having the advantage that the saturated steam has no opportunity of exerting any cooling effect on the superheated steam which must occur when both are in the same header. By this arrangement, also, it is claimed that a more even distribution of temperature in the tubes results, so that trouble with leaking flue tubes is greatly reduced. It may here be mentioned that there is another design of Horwich superheater, also designed by Mr. Hughes, known as the "Twin Plug" type, which is somewhat similar in arrangement, but has the advantage that each element may be removed without disturbing any of the others—but in everyday running the "Top and Bottom" type is found to be more satisfactory.

The cylinders are in three separate castings individually bolted to the frames, the inside pair driving the leading coupled axle through connecting-rods 6ft. 8in. long and the outside pair driving the intermediate wheels through connecting-rods 11ft. long. The steam passages have been kept as short and direct as possible. Steam distribution is effected by 9in. inside admission piston valves, having a lap of $1^{9}/_{16}$in., lead $\frac{1}{4}$in., and a maximum valve travel of $6\frac{1}{4}$in. In adopting the long valve travel, the best modern practice has been followed, and the greatly improved distribution which results more than counterbalances any disadvantages which may be urged against it. In the piston valves are incorporated Mr. Hughes' patented pressure release valves, in which steel balls are held by steam chest pressure against seatings connected by passages to the outer periphery of the valve. Any excess of pressure in the cylinder, owing to trapped steam, air, or water, automatically forces the balls off their seatings, and escapes into the steam chest.

The boiler pressure is 180 lb. per square inch, and the grate area 29.6 square feet. Each of the four cylinders is $16\frac{1}{2}$in. in diameter with a 26in. stroke. On 6ft. 3in. wheels and at 85 per cent. boiler pressure the tractive effort is nearly 29,000 lb. The evaporative surface—water side of tubes—measures 1997 square feet, of which 180 square feet are in the fire-box. The superheater has a surface of 430 square feet. The tanks carry 2000 gallons of water and the bunker $3\frac{1}{2}$ tons of coal. The total weight of the engine in running order is a trifle under 100 tons, and the total length over buffers 49ft. $10\frac{1}{2}$in. Further particulars will be found in the drawing.

On Wednesday, March 19th, No. 11,110, the first of a batch of ten of these engines being built at Horwich works, was put into steam and given a trial run. She ran with notable steadiness, and, her long wheel base notwithstanding, took a four-chain curve with ease.



L.M.S. RAILWAY—BALTIC TYPE TANK ENGINE

A Self-adjusting Ring Spanner.

We have received from the Harwol Specialties Company, of 11, Strand-street, Liverpool, a sample of a new form of ring, or box, spanner, which has just been put upon the market. It is of the self-adjusting type, and its construction is fairly obvious in the cut below.

The hexagon-shaped box is slotted on one side, and in

the recess so formed there slides a gripping jaw of hard steel. The handle is pivoted to the box, and its rear end is formed as a cam, which bears against the back of the gripping jaw. It will be seen that in this way the jaw can be adjusted to fit any sized nut within the range of the spanner, and a very powerful grip is provided.

We have tested one of these spanners, which was intended for nuts up to 1in. Whitworth, by using it to take off the nut of an old $\frac{3}{4}$in. bolt. The bolt had been riveted over heavily, beyond the nut, the whole affair was rusted up, and the corners were more or less rounded by previous efforts to get the nut off. With a 3ft. length of piping on the Harwol spanner a good grip was obtained, and the nut came off. The spanner also gripped well on a square nut, but, contrary to our expectations, could not be used as a pipe wrench.

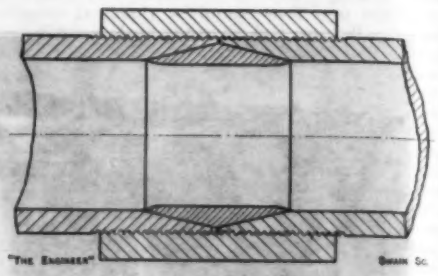
The only criticism we have to make is that the pivot might be screwed in place, instead of being riveted, so that the spanner could be easily taken to pieces. It is made in two sizes, for nuts from $\frac{3}{16}$in. to 1in., and we are told that a light type, suitable for motor cycle work, will soon be available.

CHURCHES AND OFFICE BUILDINGS.

An old Methodist church in the heart of the business district of Chicago has been replaced by a 22-storey office building surmounted by a spire extending to a height of 565ft. above the footpath, while extensive church accommodations are provided in the second storey of the building. The property belongs to the church, and in this way a large permanent revenue is assured. The building is of steel frame construction, the church and other large open spaces being spanned by steel trusses and girders which support the interior columns of the upper floors. A somewhat similar case exists at Rochester, U.S.A., where a Baptist church is to be provided in a ten-storey office building on land owned by the church. Business rooms and shops occupy the first storey; the church with its class rooms and other facilities occupies the second and third stories, while the remaining seven stories are devoted to office purposes. Separate entrances are provided. In this building heavy steel columns support trusses of 95ft. span over the main auditorium of the church, these trusses having their bottom booms in the third floor framing and their top booms in the fourth floor framing. A kitchen and dining-room are in the basement; the second storey has the main auditorium, lobby, and department rooms. Of 2,500,000 cubic feet of volume, 825,000 cubic feet will be devoted to religious purposes. This Baptist Temple building is to cost about £300,000.

Large Pipe Joints.

So very many forms of joints for pipes conveying oil, water or gases have been made that a new form would appear to be unlikely to make its appearance. It is well known, however, that pipes—as, for example, those used for conveying oil over many miles of distance—are of the screw together type, and vary from about 4in. to 14in. in diameter. The ends of these pipes, when flange joints



are not used, are screwed into collars or sockets, and the cutting of the threads in these pipes, and particularly in the sockets, is a work calling for exactness of threading and accuracy of diameter. For connecting the screwed ends of the lengths of pipe, parallel sockets screwed from each end are generally used, but in many cases, and especially where considerable pressures have to be carried, it is customary to give the threaded socket a slight taper from both ends, so that the pipe ends fit more tightly as they are screwed into the sockets, until their ends meet or nearly meet therein.

A new form of joint-making device, as above hinted, has, however, been invented, which will make it less necessary to taper the threads in the sockets, and which forms a very simple method of securing tightness against pressure in pipes and sockets accurately screwed. It consists of a simple ring tapered off at the periphery, both ways from the centre. The internal ends of the pipes are slightly tapered to the same angle—as shown, for example, by the accompanying drawing.

The ring is merely slipped into the collar and the pipes screwed tightly therein. As the internally tapered ends of the pipes are screwed into the socket and on to the ring, a radial pressure is exerted by the ring on the pipe ends, tending to swell them outwards and thereby to make an absolutely pressure-tight fit in the socket. The tightness of the joint is thereby not dependent solely on the mathematical precision of the screw thread on pipe end and in the socket. Although with the perfected system of the most recent thread-milling machinery great accuracy of these threads is ensured, the tapered socket is frequently called for, but it is thought this new ring joint will generally make this tapering of the socket less necessary.

The invention, we are informed, will be used by the Richards Thread Milling Machine Company, of London, and it is thought that it will be of interest to the makers of large tubes for oil and other pipe lines.

A preliminary conference, with the object of bringing about an international agreement on wireless telephony, was opened at Geneva on April 22nd, Mr. Isbrucker, of the Bell Telephone Company, being elected president. M. Haas, Director of the Transit Section of the League of Nations, declared that the committee of experts appointed by the League's Transit Commission had emphasised the conference being called to revise the London Convention on Wireless Telegraphy of 1912. Several speakers, including Mr. Edmonds, of London, gave accounts of the wireless telephony situation in their respective countries. Among the aims of the conference are the preparation of new international agreements on the allotting of wave lengths, the adoption of an international auxiliary language, and the organisation of a European centre for transmitting stations.

The Application of the Steam Turbine for Auxiliary Machinery.*

By RICHARD W. ALLEN, C.B.E.

THE application of turbines for driving the auxiliary machinery on ships, although it was doubtless considered as soon as the success of the turbines as a prime mover for their propulsion had been assured, lagged much behind the latter. Thus while steam turbines were used in the year 1907 for propelling purposes, very few steam turbines were installed for any auxiliary purpose until some years after this date.

The reasons for this delay were very cogent ones, and have only slowly lost their weight as the advantages of turbines became more pronounced. The first small turbines compared unfavourably with the old and well-tried high-speed forced lubrication reciprocating engines from the point of view of cost and steam consumption, and it was only after years of experiment that such improvements were effected as to lead to the change in opinion. This change was, of course, very gratifying, because it is desirable that turbine-driven ships should be fitted with turbine-driven auxiliaries.

There has certainly been during the past few years an increasing demand for turbine-driven generators and circulating pumps and other auxiliaries.

The General Advantages of the Turbine.—In order to supplant the high-speed forced lubrication steam engine, the turbine needs primarily to be simple and reliable, and secondly, to compare favourably on the score of cost, weight and steam consumption. Leaving for the moment the last consideration, the advantage of the turbine on the ground of evenness of torque, flexibility, and cleanliness enables it to take the premier place as auxiliary prime mover in ships, for it is doubtful if any engineer who has had experience of its advantages would desire to revert to the reciprocating engine. The ease with which this type of prime mover is adaptable to horizontal, vertical, or any inclined position of its spindle, not only has the advantage of enabling the auxiliary to be designed to fit into the most convenient place in the ship, and even into spaces which would be quite inaccessible for reciprocating auxiliaries, but also leads to a direct saving of weight and expense by doing away with a certain amount of structural support which is otherwise necessary. Any comparison of relative cost between a reciprocating and a turbine set must thus be made on a very broad basis and not by simply comparing the units of machinery only.

A further benefit is the absence of the reciprocating vibration, which leads to greater strains in the supporting structure and any pipes connecting to the units. The difficulty of harnessing a high-speed turbine to a low-speed pump or generator has been accomplished, as with the main propelling turbines, by the introduction of gearing.

With regard to the question of steam consumption, it must at once be admitted that up to the present and for the steam conditions generally prevailing for the auxiliary units, *i.e.*, exhausting to low-pressure stages of main turbines or to feed heaters, at about 20 lb. back pressure the turbine cannot show any initial advantage over the reciprocating engine; but the high-speed, small diameter turbines that have been lately adopted for these auxiliary units show steam consumptions that are not inferior to those of the high-speed reciprocator. Also a modern turbo unit will run for years without appreciable wear, while, on the other hand, a reciprocating engine requires frequent overhauls and adjustments, otherwise the steam consumption may be considerably higher than was shown originally on test. The turbine is also better adapted to the use of highly superheated steam, providing that suitable materials are used when in contact with high-temperature steam. The superheat is an advantage, as it ensures that no water will be present in the steam which might cause erosion of the blades. Thus, taking into consideration the question of overhaul, renewals, and reliability over a long priod of running, it may be said that the turbine is superior to the reciprocating engine. Further, as to its adaptability and freedom from vibration, and the fact that it returns its steam free of any lubricating oil to the exhaust—a valuable consideration where the supply of make-up water has to be obtained by distillation—the reasons for the favour with which a turbine-driven auxiliary is now regarded will be obvious. The present practice is to use an impulse turbine of the axial flow type, selecting such a number of wheels as will give the most simple construction consistent with low steam consumption.

Turbine Reduction Gears.—Turbine reduction gears which have played such an important part in the introduction of the turbine to the main propelling machinery, have served also, with the auxiliary machinery to an equally important degree, in permitting the coupling of a high-speed and high-efficiency turbine to a low-speed and therefore extremely reliable generator. By careful selection of material, correct design and careful workmanship in the making of the cutters and the gear-cutting machines, and extreme accuracy during the manufacture of the gear wheels and gear cases, it is now possible to produce high-speed reduction gears which are not objectionable as regards noise and which have a very high efficiency.

Turbine-driven Electric Generating Sets.—The importance of the electric power supply on board ship need not be enlarged upon, and may almost be said to be primary and not an auxiliary part of the equipment. Apart from the lighting, innumerable motor-driven auxiliaries are dependent upon the power supplied by the turbo-generators, and the demand for more power for heating and other uses is steadily growing, so that the modern dynamo-room is in itself a moderate-sized power station. As an example, ships have lately been constructed having on board turbo-generators with a total capacity of 2000 kilowatts, and larger capacities still are under consideration. It would be difficult to find the space for engine-driven sets on board ship to meet such present-day requirements. The turbine speed of capacities of 500 kilowatts to 100 kilowatts is usually 6000 revolutions per minute, and the dynamo speed 650 to 1000 revolutions per minute according to size. The turbines are of the axial flow type with wheels of 16in. to 20in. diameter. The turbines of 500 kilowatts capacity have one velocity compounded wheel having two rows of blades and one single-row wheel, whilst turbines of 100 kilowatts capacity may have one two-row wheel only. The larger turbines are coupled up to the dynamo through double helical gearing, a flexible coupling being interposed between the turbine shaft and pinion shaft. The turbines of 100 kilowatts size drive through single helical gearing, and in this case a solid coupling connects the turbine shaft and pinion shaft, the thrust due to the angle of the helical teeth being taken on the turbine thrust bearing. Michell thrust bearings are adopted in all cases. A rigid coupling is invariably used between the slow-speed shaft of the gear and the dynamo shaft, and the main gear wheel bearing takes the load of the armature shaft. Oil under pressure is provided by a rotary oil pump driven from the governor spindle for lubrication of the bearings and gears. The oil from the bearings drains back to the tank in the base-plate underneath the gear-box, and passes through a strainer before being re-circulated by the oil pump. The oil is delivered by the pump at about 25 lb. pressure, at which pressure it is used for operating the governor, and is then reduced to about 10 lb. before it is passed through the oil cooler to the bearings, a fine strainer being interposed between the cooler and bearings. Speed and emergency governors are fitted.

Turbine-driven Centrifugal Circulating Pumps.—Turbine drive has now been successfully applied to many of the large circulating pumps. The demand of the main turbines for high vacuum adds considerably to the importance

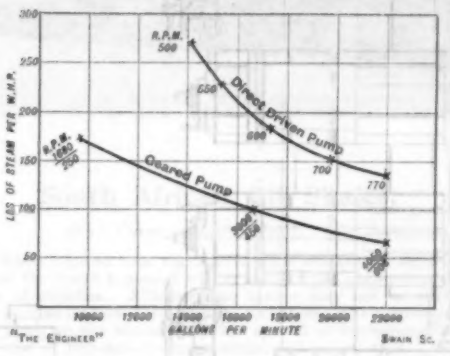


FIG. 1

of the condensing plant, and both air and water extraction and circulating water pumps must be driven by a particularly reliable source of power. Turbine-driven centrifugal pumps with either horizontal or vertical spindles giving a compact and silent running combination, have been designed. In many cases they can be coupled direct to the turbine. The tendency, however, is to introduce a reducing gear between the turbine and pumps in order to obtain better economy in steam consumption. In this connection it may be mentioned that a recent example of a geared turbine pump delivering 22,000 gallons per minute against a head of 22ft. had a steam consumption only half that of a direct turbine-driven pump of similar output constructed a few years ago. It may be of interest to compare the steam consumptions of these two types of circulating pumps under the same steam conditions. The curves shown in Fig. 1 indicate very clearly the saving in steam consumption over a considerable range of output of the geared set as compared with the direct-driven set, while the following table gives the particulars and the steam consumptions of the types of pump compared.

Comparison of Steam Consumption of Pumps.

Pump particulars.	Turbine direct-driv'n centrifugal pump.	Turbine gear-driven centrifugal pump.	Engine-driven centrifugal pump.
Pump revolutions per minute	770	600	515
Quantity of water delivered per min., gallons	22,000	22,000	26,250
Head of water, feet ..	22	22	22.2
Steam consumption, lb. per hour	19,870	9,744	9,080
Lb. of steam per W.H.P.	135	66	66.6

Turbine-driven Salvage Bilge Pumps for Boiler-rooms.—An interesting example of the adaptability of the turbine to the driving of vertical spindle pumps is seen in the pipeless bilge pump specially designed for installing in boiler-rooms. This pump has many interesting features. It is driven from the turbine by means of a vertical intermediate shaft, which can be made of any reasonable length, thus enabling the turbine itself to be placed well above the water line. To compensate for any lack of alignment between the turbine and the pump this intermediate shaft is connected to the turbine spindle by a flexible coupling, while the whole weight of the rotating parts is carried on Michell thrust bearings, one above and one below the flexible coupling. The turbine is of the single-stage impulse type. Both pump and turbine bearings are automatically lubricated, the pump bearings being of lignum vitæ, water lubricated from the pump itself, while the turbine lubrication is provided by a gear-driven oil pump. A novel feature is that as the pump is mounted directly on the tank top or inner bottom of the vessel, there is no pipe work, this arrangement enabling it to draw direct from the bilge through a removable strainer and discharge through a non-return valve. Thus, not only are the usual risks of pipe damage avoided, but the first cost and weight of the installation is considerably reduced, with the result that the set is very compact and light, only weighing 43 cwt. in all.

Turbine-driven Boiler Feed Pumps.—The turbine-driven centrifugal feed pump may be cited as another example of the value of this drive. The duty in question demands strength and reliability, which are the outstanding qualities of a turbine-driven installation. A boiler feed pump is an important auxiliary, and as a unit must be absolutely dependable. The pump described is of the multi-stage type, having three stages, and is capable, when driven at a speed of 4250 revolutions per minute, of delivering against a boiler pressure of 225 lb. The turbine-driven boiler feed pump occupies very little space, and on account of the high speed at which it runs the weight per brake horse-power developed is low. The steam turbine utilised to drive the pump has a single wheel with three rows of blades. The turbine and pump bearings are cooled and lubricated with oil supplied under pressure. A feature of the turbine-driven boiler feed pump is that the speed of the unit may be varied automatically so as to give a constant pressure at the discharge branch of the pump, with a very wide range of quantities. The delivery from the pump is steady, continuous and without pulsation, and the pipes are not subject to shock. The pump is also fitted with an automatic balancing device, and this will work satisfactorily even when the pump is delivering very small quantities of water. This enables the unit to feed the boilers economically when the ships put into port.

Turbine-driven Boiler-room Fans.—Much more attention is paid nowadays to the question of the supply of air to boiler-rooms than was formerly the case, and that an economical and highly efficient supply can be obtained by steam turbine-driven fans is evident from the large number of such sets that have been installed in later years. It is necessary, however, to provide for adequate and properly designed deck intakes, cowls, weather flaps and shutters, so as to allow the air to flow without loss due to eddy currents; while at the same time the possibility of the entry of water must be prevented. The fans may have vertical, horizontal, or inclined shafts. On ships there is frequently so little room allowed for them that a different design is needed for each individual case. Whereas, until recently, the turbine was directly connected to the fan, the present practice tends to take advantage of reducing gears in order to utilise a small and more efficient turbine wheel running at a high speed, whilst at the same time keeping the speed of the fan down to a convenient limit with respect to high efficiency and moderate stresses. In all cases forced lubrication is adopted, and particular attention is paid to the bearing which carries the overhung fan wheel. The space provided for boiler-room fans is usually restricted and inconvenient of access, and it is under these conditions that the attributes of the turbine-driven fan, either geared or direct, show up to best advantage, as the space occupied and the attention required by the turbine-driven fan are much less than those required by engine-driven fans. Also accessibility is of less consequence when renewals and overhauls are less frequently required, as is the case with the turbine-driven set. Among the other advantages of turbo-driven fans may be noted that they may be small and light for a given output; that they may be bolted up to the deck, thus enabling the fan flats to be dispensed with.

The Adaptability of the Turbine to the General Arrangement of the Machinery in Engine and Boiler-rooms.—After the position and space occupied by the main propelling machinery has been fixed upon the auxiliary machinery on board ship has to be disposed to best advantage with respect to its purpose. The space for the auxiliaries is thus often cramped, but as the satisfactory running of the ship is absolutely dependent on each and every one of the auxiliaries performing its specific duty, no effort must be spared in arranging each auxiliary convenient to its work and accessible for attention and overhauling. The turbine-driven auxiliary, by reason of the smaller space occupied, its simplicity of construction, and the accessibility of its vital parts for overhauling, permits of its being placed where the engine-driven auxiliary could only, if at all, be placed to serious disadvantage. Further, in the case of the turbo-generator, it can be located on a gallery with small headroom and light supporting structure. The engine-driven set, on the other hand, must have considerable headroom, both on account of its greater height and for removal of the pistons, and must have substantial support to take the unbalanced reciprocating forces which would otherwise cause severe vibration. The following table shows the relative space occupied by turbine and engine auxiliaries.

Relative space occupied by Turbine and Engine Auxiliaries.

Size of unit.	Turbine.			Engine.			Cubic feet space occupied.		Per cent. saving in space.
	Length.	Width.	Height.	Length.	Width.	Height.	Turbine.	Engine.	
Electric Generators.	ft. in.	ft. in.	ft. in.	ft. in.	ft. in.	ft. in.			
400 kilowatts	14 0	7 0	5 6	21 0	10 0	12 0	540	2500	79
100 kilowatts	8 6	5 0	4 6	10 9	5 3	8 0	190	450	58
Circulating Pumps.									
29,000 G.P.M., 38ft. head	12 0	7 0	7 0	12 0	7 6	12 0	590	1080	45
22,000 G.P.M., 22ft. head	5 6	4 9	10 0	10 3	5 0	10 3	260	525	50
Boiler-room Fans.									
50,000 cub. ft. per min., 6in. W.G. ..	6 6	5 0	5 0	5 3	7 4	8 6	162	325	50

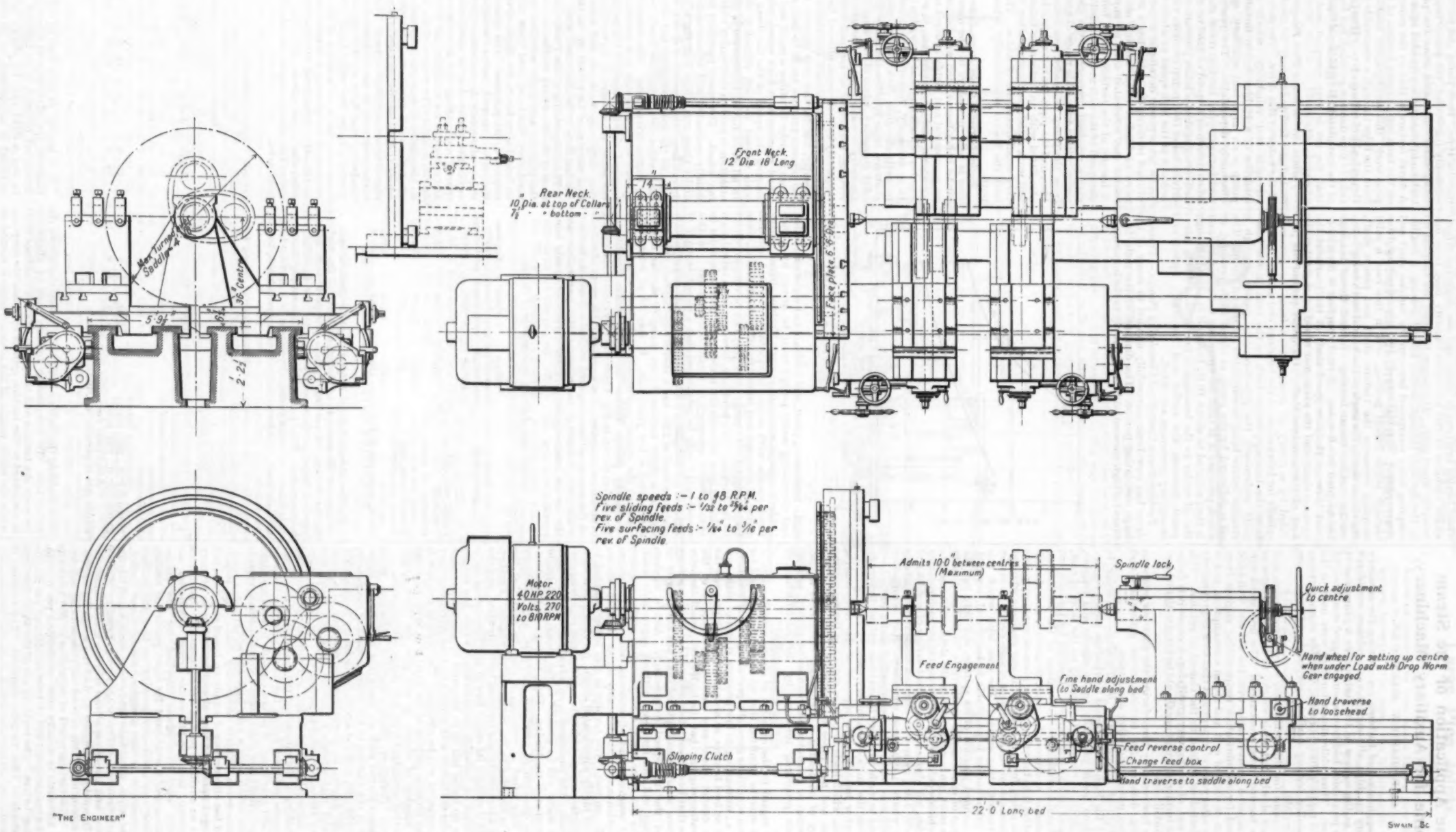
It is worthy of note that as the power of the auxiliary increases the advantage in space occupied by the turbine-driven set becomes more marked. A considerable saving in net weight can be shown when the turbine-driven auxiliary is substituted for its engine-driven counterpart, and the accompanying table shows what can be done in

* Abstract of paper, Institution of Naval Architects.

A LARGE LOCOMOTIVE CRANK AXLE LATHE

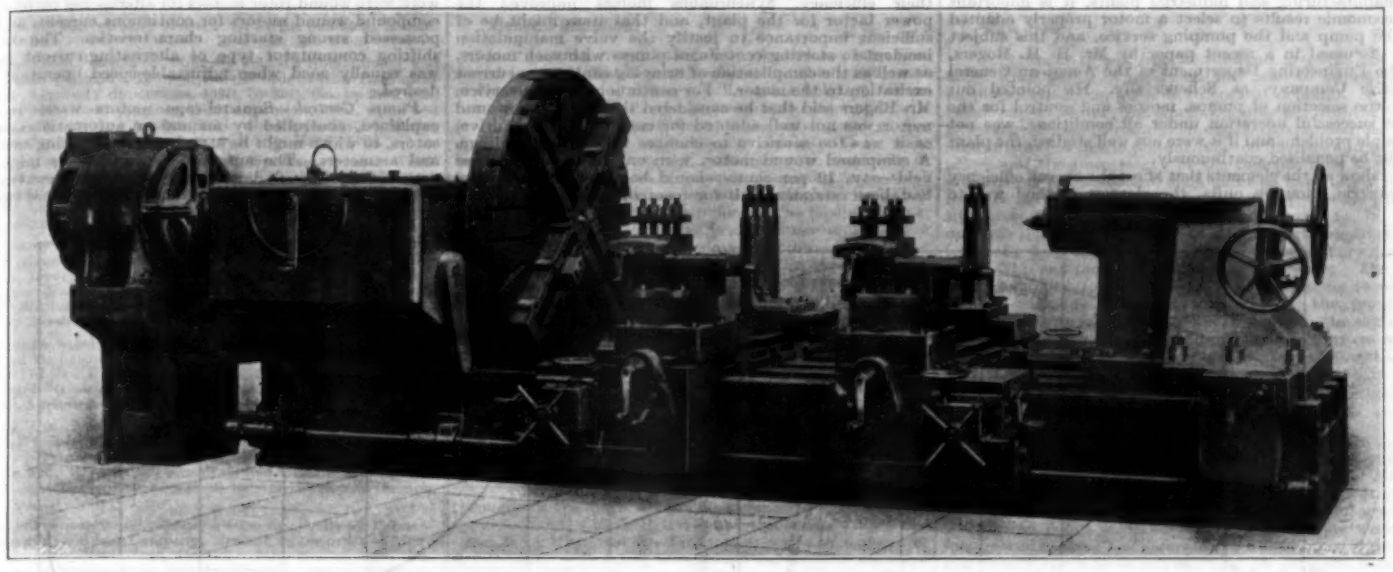
JOSHUA BUCKTON AND CO., LIMITED, LEEDS, ENGINEERS

(For description see opposite page.)


Front Neck. 12 Dia. 18 Long
Rear Neck. 10 Dia. at top of Collar
7⅛ " " bottom "
Face plate 6'-0" Dia.
Spindle speeds :- 1 to 48 R.P.M.
Five sliding feeds :- 1/32 to 5/64 per rev. of Spindle.
Five surfacing feeds :- 1/64 to 5/16 per rev. of Spindle
Motor 40 HP 220 Volts. 270 to 810 RPM
Admits 10'0" between centres (Maximum)
Spindle lock
Quick adjustment to centre
Hand wheel for setting up centre when under Load with Drop Worm Gear engaged
Feed Engagement
Fine hand adjustment to Saddle along bed
Hand traverse to loosehead
Slipping Clutch
Feed reverse control
Change feed box
Hand traverse to saddle along bed
22'0 Long bed
SWAIN Sc.
"THE ENGINEER"

LOCOMOTIVE CRANK AXLE LATHE.

JOSHUA BUCKTON AND CO., LIMITED, LEEDS, ENGINEERS.



this respect, the weights being those of exactly similar power and capacity:—

Size of unit.	Weights given in cwt. per set.		Per cent. saving in weight.
	Turbine.	Engine.	
Electric Generators—			
400 kilowatts	254	686	63
100 kilowatts	78	160	51
Circulating Pumps—			
29,000 G.P.M., 38ft. head ..	145	230	37
22,000 G.P.M., 22ft. head ..	90	105	15
Boiler-room Fans—			
50,000 cubic feet, 6in. W.G. ..	19	26	27

A Large Crank Axle Lathe.

WE had the pleasure of examining recently at the works of Joshua Buckton and Co., Limited, Leeds, a very fine crank axle lathe which the firm has just completed for Cammell Laird and Co., Limited, Sheffield, by whom it will be used for the rapid production of locomotive crank axles. It has been designed to take very heavy roughing cuts and yet to finish with the accuracy demanded in locomotive work.

The bed is of the four-shear box section type, and is 22ft. long, so that the lathe will take 10ft. between centres. The fast and loose headstocks are mounted on the shears, which carry also two front and two rear saddles. A variable speed motor of 40 horse-power drives the lathe through a train of gearing which ends with a pinion driving a steel internal gear bolted on the back of the face-plate, which is 6ft. 6in. in diameter. Three changes of gear are provided, and in conjunction with the variable speed motor spindle speeds ranging between 1 and 48 revolutions per minute are obtainable. The gear changes are controlled by a single lever on the front of the headstock. The motor, it will be seen from the illustrations that accompany this article, stands upon a pedestal which is separate from, but bolted to, the lathe proper. It is connected to the gear-box by a Wellman-Bibby coupling. The gears throughout are cut from steel and run in an oil bath.

The main spindle, which is of high carbon steel, has a front journal 12in. in diameter by 18in. long, running in capped and bushed gun-metal bearings. The thrust is taken at the tail end by six marine type thrust collars, which, of course, are adjustable. Lubrication is effected by wicks from large oil wells above the bearings, and the oil leaving the bearing is collected in special detachable receivers.

The loose headstock, which is traversed by a worm wheel driving a pinion in a rack, has a 7in. steel spindle, provided with a screw for quickly running it in and out. A large worm wheel is keyed to the screw, and with it a drop worm rotated by a hand wheel engages when desired in order to screw the centre up under load. The usual pad is provided for locking the spindle in position, and bolts and clamping plates for holding the loose headstock in place.

There are four hatchet rests and two compound slide rests—the latter for use on the two front saddles in place of hatchet rests when desired. All the saddles are guided on one shear only—that is to say, one shear for the back pair and one shear for the front pair. They can be moved in the usual way along the bed by hand wheels or are fed automatically by two shafts running the length of the bed, which makes three revolutions to every one of the spindle. These shafts are driven by gearing, not by chain. The feeds are engaged and disengaged by drop worms, and slipping clutches on the shafts obviate damage. The control gear for the saddles is mounted on the saddles themselves, and safety locks prevent the simultaneous engagement of two feeds.

The lathe will turn a diameter of 4ft. 10in. over the saddles, and weighs about 40 tons. Of the workmanship we need say no more than that it is of the standard expected in Buckton tools.

South African Oil Shales.

(By a Correspondent in South Africa.)

FROM time to time there have been sensational reports that the world is almost within sight of the exhaustion of its oil supplies. Although the danger may not be quite so near as alarmists would have us believe, it is significant to learn on the authority of the special oil correspondent of one of Britain's leading commercial papers that "the American oil industry has made up its mind that the period of crude oil overproduction went out with the old year, and that a period of domestic oil shortage is approaching, and that a new cycle of ascending oil prices has already commenced."

Presuming this to be in the main correct, it would seem that the prospects of the various companies, which have been formed within the Union of South Africa quite recently for the purpose of working the rich Torbanite deposits of the country, are encouraging to the highest degree. These prospects have been multiplied quite recently—in fact, within the last few weeks—by a new method of retorting which has been invented by a young engineer on the Witwatersrand, Transvaal Province.

To deal first with the Torbanite deposits themselves, which are already proved and ignoring any known occurrences of liquid petroleum—as not being of any magnitude—we find that beds of oil shale occur in the Transvaal, Natal and Cape Provinces. At Impendhle, Natal, the contents of the proved area have been estimated by Mr. Mills-Davies, consulting engineer, at considerably over 7,000,000 tons, with an average value of not less than 30 gallons of crude oil per ton. The Hlatimbe Valley oil shales have a total area of 6700 acres. The shale seams have been proved by adits and cuttings. They are 3ft. thick and show a tonnage of 700,000 tons per claim over the ten claims so far proved. A test of these oil shales made at the Pumpherston Works of Scotland gave very satisfactory results.

In Griqua West a valuable deposit exists. The assays there give 12 gallons of petrol and 40 gallons of strong ammonia, and the area proved by bore-holes is from 40 to 50 acres. This is only a small portion of the area on which the deposits exist. The shale is 8ft. thick.

It is, however, to the Ermelo district that the companies at present in existence are turning their attention. The oil shales occur there in three veins. The lowest has a thickness of 20ft. to 24ft.; the middle one 19ft.; and the top one from 2ft. to 3ft. As the district is crossed by the Breyton–Ermelo Railway, the transport facilities are excellent. This district has been thoroughly proved, and has been reported upon by the best engineers and geologists in the country. Mr. J. E. Mills-Davies, Mr. A. G. Maclatchy and Mr. G. A. Troye have all reported separately, and are in substantial agreement regarding the potential value of the find. The seam on the "Maviriestad" farm in this district covers a proved area of about 7000 acres, and yields with ordinary methods 18 to 28 gallons of crude oil per short ton. Not far away from this deposit are others, one of which is said to be even more extensive. At Wakkerstroom, Elandspoort and Slangopies are other great deposits. With regard to the latter-named place, excellent reports have been made by Dr. Alex. Bair, Dr. Hans Merensky, Dr. P. Wagner, and Messrs. E. H. Cunningham-Craig, E. H. Hunt, T. G. Colquhoun and F. W. Girdler Brown. The yield runs 30 gallons per ton with ordinary methods, and the deposit runs into many millions of tons of oil shale.

There are a large number of other areas containing large deposits, and among the principal may be mentioned Elandsdraai, Cape Province, near Kimberley, on the Orange River. There, borings have proved the existence on 50 acres of 1,250,000 tons. The property embraces some 50,000 acres in the direction in which the oil shale is known to extend. Considerable prospecting is going on in this direction.

There is no need to refer in detail to other deposits, except to say that the quantities of payable shales are estimated as quite likely to run in the aggregate into thousands of millions of tons. Difficulties of transport, however, at present rule many of them out of consideration.

The reservation made above, in reference to yield, that it runs so many gallons "with ordinary methods," is necessary, because during the latter part of last year a Lamplough-Harpur plant was brought out here and revolutionised values with yields of about 60 gallons per ton. But even this record has been beaten during the last few months by the invention of a young Witwatersrand engineer, which has been carefully tested in the presence of scientists and engineers. Two separate runs have been made with it, one on Torbanite and one on coal, and all present expressed themselves as perfectly satisfied that the retort does all that was claimed for it. The retort invented by the Rand man proved, it is said, that Ermelo Torbanite treated contained 100 gallons per ton, which chemists here state is superior to best Pennsylvanian crude oil. This Torbanite crude oil, when distilled in the same retort, produces 40 gallons of motor spirit, in addition to quantities of paraffin and spindle oil per ton of Torbanite.

In an experiment on powdered Ermelo coal, 6 lb. were put through the retort, and the crude tar oil extracted weighed 1¼ lb. This result was obtained, notwithstanding that, owing to there being only a partial condensing plant, a proportion of the light oil vapours generated in the retort escaped into the atmosphere.

The recovery stated included some of the water contents of the coal—possibly 5 per cent. of the total recovery—that had condensed during the treatment. That would, however, be more than counterbalanced by the certain recovery of the lighter oils in a complete condensing plant. Therefore, the net recovery was 20.8 per cent. of oil tar, or 40 gallons per ton of coal treated.

It is noteworthy that the young engineer responsible for the production of this practical retort, which solves the apparently insuperable difficulties met with in treating coal without cracking the oil vapours, has worked on lines almost parallel to those laid down by able chemical experts; that is, the continuous recovery method. Without any "caking" in the retort, he has proved by actual results of continuous practical tests that the extraction of crude oil and tar from local bituminous coal can be carried out on a commercial basis; for the operating costs of the production of crude oil and tar by this method is extremely low, and the practical results so far achieved are eminently satisfactory.

An extraordinary feature of this local invention is that a unit of plant capable of producing 300 gallons of crude oil, made in Johannesburg, will cost less than £100, while such a unit of older methods, if obtained from overseas makers, would cost four times that amount at least, and take a long period to erect.

The area of ground held by the new company is approximately 35,000 acres in the Ermelo district. By means of bore-holes, shafts, prospecting pits, and adits, a composite seam, consisting of Torbanite and coal, of excellent quality and workable thickness, has been proved to exist over the property. The well-known expert, Mr. Cunningham-Craig, has stated that from a geological point of view, the tonnage of Torbanite in sight is probably not less than 20 millions, and may be greater. He considers that the Torbanite bench in the seam will probably be from 10in. to 18in. in thickness, with an average thickness of 12in. Experiments are now being conducted with oil shale found in other parts of the Transvaal and Natal.

IN a paper read before the Institute of Marine Engineers, Mr. P. J. Higgs suggests that the Diesel-electric drive compares favourably in practically every factor with the turbine. In the important factor of reliability, however, only practical experience can give evidence, but the Diesel-electric does not suggest any serious defects over other systems in this respect. Disadvantages of Diesel-electric lay-out are:—(1) Higher initial cost; (2) a greater number of moving parts, and therefore the larger skilled *personnel* for attention. The advantages are:—(1) It permits the application of Diesel engines with the incidental lower running costs to liners; (2) the lower fuel cost is of such magnitude as to offset entirely the most generous allowances that may be made for any probable expenses peculiar to the motor ship alone, and still to show a better return on invested capital.

Electrically-operated Pumps in Industrial Plants.

In electrically-operated pumping units, for service at manufacturing and industrial plants, it is important for economic results to select a motor properly adapted to the pump and the pumping service, and this subject was discussed in a recent paper by Mr. R. H. Rogers, of the Engineering Department of the American General Electric Company, at Schenectady. He pointed out that the selection of pumps, motors and control for the most successful operation under all conditions, was not a simple problem, and if it were not well studied, the plant might be penalised continuously.

To show all the elements that affect the overall efficiency of electric pumping units, the clearest method was to analyse the entire service from the electric meter to the work accomplished. The items that directly affected the kilowatt-hours per million gallon feet were :—(*a*) the ratio of dynamic head to static head ; (*b*) the pump characteristics ; (*c*) the pump not operating at proper rating ; and (*d*) the motors.

Ratio of Head.—The static measured or calculated vertical head in pumping against pressure, such as boiler pressure, was not the measure of the pump's work, for every foot of pipe, as well as every valve or elbow or other fitting, increased the actual or dynamic head. For instance, with regard to pipe diameter, a 5in. three-stage centrifugal pump delivering 400 gallons per minute through 300ft. of 5in. pipe would cost in annual operation about £75 more than if connected to 10in. pipe. That difference would soon pay the extra cost of the larger pipe. In general, said Mr. Rogers, the piping should have much greater area than the pump openings, as high velocity was essential in the pump but detrimental in the piping. In fact, he considered that the velocity in the latter should not exceed 6ft. to 8ft. per second. The suction pipe should be deeply immersed, should be as short as was practicable, consistent with good installation practice, and, if it included bends, they should be of long radius.

Pump Characteristics.—The character of a centrifugal pump was shown by a chart, on which were plotted the head, gallons per minute, efficiency, revolutions per minute and horse-power. Such a chart is given in Fig. 1, with typical curves for constant speed. It was pointed out that the efficiency was high and fairly flat, from 70ft. to 97ft. head, and from 4000 to 5600 gallons per minute ; and that, therefore, the pump could be applied efficiently between these limits. The horse-power fell off in both ways, so that the motor could be overloaded. If the speed at the point of highest efficiency was at or near that of an induction motor it would insure, said Mr. Rogers, its operation at the most efficient point if directly connected to a squirrel-cage induction motor. If the horse-power required at the most efficient point was near that of one of the standard squirrel-cage motor ratings, it would insure a high overall efficiency for the unit. It was fortunate, he continued, that induction motors had a very flat efficiency curve through the working range, such as 90 per cent. at full load, 90.5 at 75 per cent. load, and 90 per cent. at 50 per cent. load, so that that feature had little effect. However, the power factors of such motors required that they should be operated at near full load in order to keep the current at a minimum. Power factor affected only the leads and generating system, and did not affect the meter, except as the meter rates might be adjusted to penalise low power factor in a plant. At loads as given above the power factor might be in the order of 89, 87 and 80 per cent. A desirable characteristic in centrifugal pumps was that of having the load fall off each way from the best operating point. That prevented an overload coming on the motor by an accident or by the mishandling of valves, which would subject it to maximum head (closed off) or minimum head (direct discharge).

Pump Operating Rating.—Pumps, Mr. Rogers went on to say, were rated at their best operating point, and any deviation in speed, head or delivery would result in a higher cost per unit of duty, and while some future conditions might have to be given consideration, the operating of a pump at lower than rated head should be avoided, especially when a constant-speed motor was used. The chart—Fig. 2—he said, showed the variations in kilowatt-hours per million gallon feet pumped by a 10in. centrifugal pump directly connected to the constant speed motor, which gave the highest overall efficiency at the pump rating. The gallon-feet pumped in a year at 135ft. head for £1820, at 1d. per kilowatt hour, would cost £3400 if pumped at 45ft. head with a pump of that class. The difference of £1580 per year, Mr. Rogers thought, was not out of line with many pumping duty costs that might be found among misapplied pumps in industrial plants.

Choice of Motor.—For constant speed service either induction motors of the squirrel-cage type or synchronous motors might be used. There was little difference in their efficiency. Synchronous motors improved the power factor for the plant, and that item might be of sufficient importance to justify the valve manipulation incident to starting centrifugal pumps with such motors, as well as the complication of bringing continuous current excitation to the motor. For continuous current service, Mr. Rogers said that he considered that the shunt-wound motor was not well adapted for centrifugal pump drive, as it was too sensitive to changes in load and voltage. A compound wound motor, with only a moderate series field—say, 10 per cent.—should be used. Such motors had been standardised for centrifugal pump service.

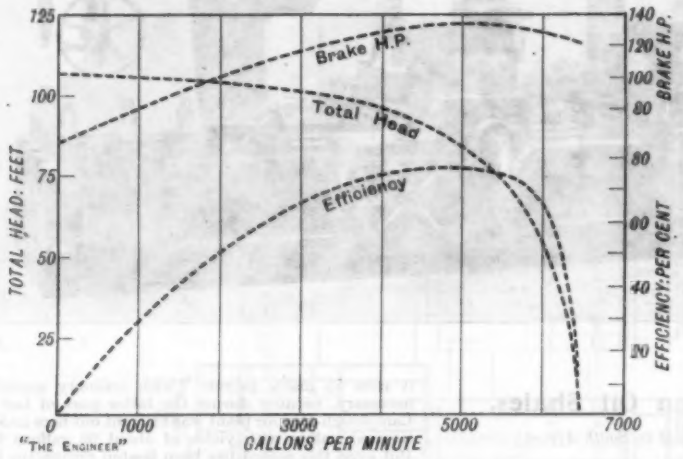


FIG. 1

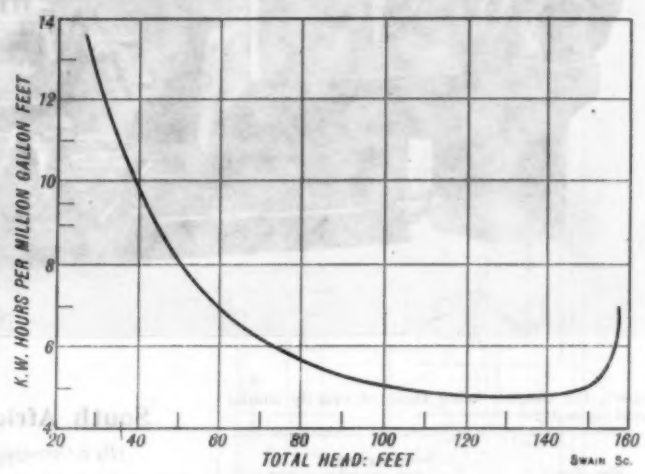
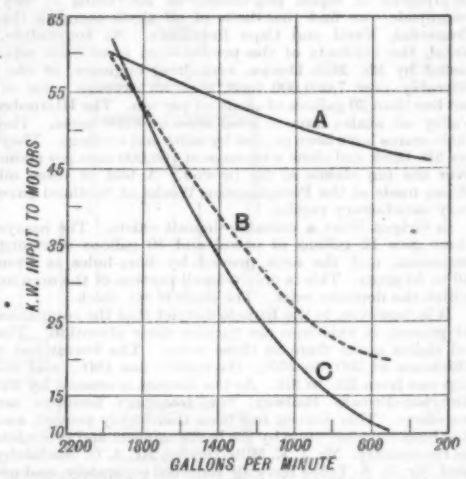


FIG. 2

For pump drives of adjustable speed, motors of the wound rotor-type or the brush shifting commutator type, might be used. The latter had much higher efficiency at reduced speeds, a feature which was considered to justify their higher cost if operated below normal speed frequently or for long periods. In Fig. 3 was shown the relative outlay in kilowatt-hours for an adjustable-speed pump using both wound rotor and brush-shifting motors. A third curve showed the high cost of throttling to obtain reduced output. From that chart Mr. Rogers showed that at 60 per cent. of normal pump output, the brush-shifting motor would operate 24 hours for £2 ; the wound-rotor motor for £3 ; and the squirrel-cage motor, with throttled pump, for £5. The differences became greater as the output was still further reduced.

Vertical motors might often be used to advantage by arranging the pump at any necessary depth below the motor-room floor, thus reducing or eliminating the suction lift, with consequent benefit to the overall efficiency. When the water contained much grit or where the pump was inaccessible, the weight of the revolving parts might be carried on a suspension thrust bearing at the top of the vertical motor. That arrangement allowed of easy inspection and maintenance. Vertical motors were available in synchronous, squirrel-cage, wound rotor, brush shifting and continuous current construction. Squirrel-cage motors could be used on centrifugal pumps up to 500 horse-power, provided that the inrush of starting current was not objectionable. Wound-rotor motors started with much less line disturbance and were used for that reason even when intended for constant speed duty. Synchronous motors were not usually installed for units below 75 horse-power, and they, of course, were only for constant speed duty.



A. *75 H.P. 1800 Synchronous Motor throttled to capacities given.*

B. *Wound Rotor Motor; speed reduced by Rheostat in Secondary Winding for capacities given.*

C. *Brush Shifting A.C. Commutator Motor; speed reduced by Shifting Brushes for capacities given.*

"THE ENGINEER" SWAIN Sc.

FIG. 3

Reciprocating pumps, rotary pumps and screw pumps had heavy starting duty owing to high breakaway torque and full load pumping duty from the start. Therefore, squirrel-cage motors could not be used if the line disturbance were objectionable. If synchronous motors were used the pump must be relieved of its load in starting, so that the motor could pull into step. In Mr. Rogers' opinion the best motors for pumps of that class of work were wound-rotor motors for alternating current and compound-wound motors for continuous current, as they possessed strong starting characteristics. The brush-shifting commutator type of alternating-current motor was equally good when adjustable-speed operation was desired.

Pump Control.—Squirrel-cage motors were, it was explained, controlled by manual or automatic compensators, to which might be attached disconnecting switches and ammeters. The automatic compensators might be actuated by a push button placed at some convenient point, by a thermostat or by a diaphragm pressure switch. Wound-rotor motors for constant speed duty might be controlled by an automatic panel actuated by push button or a float switch. When adjustable speed was required, or when it is desired to control the starting by hand, a manual rheostat was provided in the secondary circuit, while the line contact was made by a manual or magnetic switch.

Synchronous motors were, said Mr. Rogers, controlled usually by a compensator and a field discharge switch. Brush-shifting motors required only some form of line switch with overload protection and a mechanical means for shifting the brushes. This latter might be a hand wheel, a shipper rod or a small pilot motor actuated by remote push buttons. Compound-wound continuous-current motors for centrifugal pumps required a disconnecting switch and a hand starter, while if adjustable speed was required a manual field regulating rheostat was added. Continuous-current motors might, he added, be controlled also by magnetic panels actuated by push button or float switch, as in the case of alternating-current motors.

Control apparatus in all cases should be fully enclosed and provided with protection against overload and under-voltage. When it was desired to have the motor restart by itself, after an under-voltage shut down, an under-voltage release must be applied. Such a release must also be provided if the motor was to be started by a float switch or other auxiliary circuit-closing device. The submergence of contact-making parts in oil was necessary when explosive gases or highly-corrosive acid fumes were present. A battery of motor-driven petrol pumps in an oil refinery had switches of the oil-immersed type, and as a squirrel-cage motor had no moving contacts, there was the danger of starting a fire or explosion. At another plant an acid pump was, added Mr. Rogers, driven by a 40 horse-power squirrel cage motor controlled by a standard compensator having its contacts submerged in oil. The motor was not liable to injury by the fumes as there were no vital parts exposed.

Pump Service.—In conclusion, Mr. Rogers pointed out that motor-driven pumps were operating successfully an exacting class of service in industrial plants. They handled thick, light and volatile liquids, acids, &c., under manual or automatic control. The flexibility of electric drive allowed the plant engineer to draw a straight line from suction level to discharge level, and to put the pump in line practically without bends, with the assurance that he could bring the power to the pump without any loss in efficiency or any inconvenience to the plant.

Dunedin City, New Zealand, is extending the Waipori Falls station by the addition of a 3000-kilowatt unit, and is making provision for the ultimate installation of three more such units. The Southland Power Board is pushing on the Monowai scheme of two 2000-kilowatt units, with provision for extension by four additional units. The New Plymouth Borough has plans in hand for a station of 4500 kilowatts on the Waiwakaiho River, and the Taranaki Power Board proposes to construct a small station of 1500 kilowatts at Tariki.

By his will, Dr. P. H. Dudley, consulting engineer of the New York Central, whose death we announced on March 28th, left the bulk of his property to Yale University for the establishment of a professorship "which shall be devoted to research and instruction in connection with the history and development of the science of railway service." The New York Central Railroad receives his stremmatograph, the apparatus to record the movement of rails under the passage of trains, and his microscope, "for the use of the consulting engineer in charge of the department of rails, ties and structural steel."

LAUNCHES AND TRIAL TRIPS.

IOSSIFOGLU, single-screw steel motor ship; built by Swan, Hunter and Wigham Richardson, Limited; to the order of the Ionian Marine and Land Investment Company, Limited; dimensions, 400ft. by 53ft. 6in. by 28ft. 3in.; 8250 tons deadweight. Engines, one set of Neptune oil engines, six cylinders, 22½in. diameter by 45in. stroke; constructed by the builders; launch, March 24th.

SALMONPOOL, steamer; built by Irvine's Shipbuilding and Dry Docks Company, Limited, to the order of Sir R. Ropner and Co., Limited; dimensions, 403ft. by 55ft. 6in. by 28ft. 3in.; to carry 8600 tons. Engines, triple-expansion, 26in., 43in., and 72in. by 48in. stroke; constructed by the North-Eastern Marine Engineering Company, Limited; trial trip, March 24th.

LUXMI, single-screw vessel; built by Harland and Wolff, Limited, to the order of Andrew Weir and Co., Limited; dimensions, 384ft. by 48ft. by 36ft.; 4320 gross tonnage; engines, one set of six-cylinder Diesel. Constructed by the builders. Delivered March 25th.

STOTTPOOL, single-screw steamship; built by Swan, Hunter and Wigham Richardson, Limited; to the order of T. B. Stott and Co., Liverpool; dimensions, 256ft. by 38ft. 2in. by 17ft. 3in.; 2500 tons deadweight. Engines, triple-expansion; constructed by the Shields Engineering and Dry Dock Company, Limited; launch, March 25th.

AMAPALA, steel screw steamer; built by Swan, Hunter and Wigham Richardson, Limited, to the order of Vaccaro Bros. and Co., of New Orleans; dimensions, 360ft. by 50ft. Engines, four-crank triple-expansion; constructed by the builders; launch, April 3rd.

CORY OIL, No. 1; steel screw oil tank barge; built by Palmers' Shipbuilding and Iron Company, Limited, to the order of Cory Brothers and Co., Limited; dimensions, 100ft. by 24ft. by 11ft. 3in.; to carry 300 tons of oil fuel. Engines, compound surface condensing; constructed by the builders; launch, April 3rd.

MELAMPUS, cargo and passenger steamer; built by Palmers' Shipbuilding and Iron Company, Limited, to the order of Alfred Holt and Co.; dimensions, 448ft. by 54ft. 9in. by 32ft. 9in.; single-screw actuated by double-reduction geared turbines; constructed by the builders; launch, April 4th.

SALMO, single screw cargo steamer; built by Swan, Hunter and Wigham Richardson, Limited, to the order of the Ellerman Wilson Line, Limited; dimensions, 237ft. by 35ft. by 17ft. 9in.; 1900 tons deadweight. Engines, direct acting, triple-expansion, surface condensing type, pressure 225 lb.; constructed by the Wallsend Slipway and Engineering Company, Limited; trial trip, April 10th.

PERSONAL AND BUSINESS ANNOUNCEMENTS.

THE Consolidated Pneumatic Tool Company, Limited, of Egyptian House, 170, Piccadilly, London, W. 1, asks us to state that the address of its Leeds office has been changed to 67, St. Pauls-street, Leeds.

SAMUELSON AND CO., Limited, of Britannia Works, Banbury, ask us to announce that they are no longer represented in Manchester and the adjoining districts by Messrs. B. W. Lumley and Co., and they request that all inquiries, &c., should be sent direct to their works at Banbury until further notice.

THE Council of the Institution of Production Engineers announces with regret the resignation of its secretary, Mr. A. T. Davey, necessitated by his leaving London to take up a position with W. H. Allen and Sons, Limited, of Bedford. The honorary secretaryship will in future be filled by Mr. E. D. Ball, 20, Lushington-road, Harlesden, N.W. 10, to whom all communications should be addressed.

MR. JAMES M. DEWAR, M.I. Mech. E., M. Inst. N.A., M.I. Mar. E., informs us that he has taken offices at 1, Charing Cross, London, S.W. 1 (telegrams, "Dewarmina, Westrand, London," and telephone, Regent 5672), where he proposes to practise as a consulting marine engineer and naval architect, acting in co-operation with Mr. A. T. Wall, A.R.C.Sc., M. Inst. N.A., consulting naval architect, 707–11, Royal Liver Building, Liverpool (telegrams, "Protection, Liverpool," and telephone, Liverpool Central 201).

CONTRACTS.

WE are informed that the Hodroyd Coal Company, Limited, has placed orders with the Westinghouse Brake and Saxby Signal Company, Limited, for complete electro-pneumatic decking plant for its two-deck cages at the pit top of the Brierley Colliery, and for decking plant comprising two rams, &c., for the single-deck cages at the Ferry Moor Colliery.

A NEW JOINTING MATERIAL.—Brown Brothers, of Great Eastern-street, London, E.C. 2, have sent us a sample of their Vellumoid sheet jointing, which is intended for making tight joints subject to oil under pressure, for air pipes, &c., but should not be used for services where the temperature is liable to rise above 300 deg. Fah. It is a vegetable fibre material, and appears to be eminently suitable for such services, being of a readily compressible nature, easily cut to shape by a knife, like soft leather, and, according to report, actually improved in quality by exposure to oil. It is made in various thicknesses from 0.005in. up to ¼in.

THE CHELMSFORD ENGINEERING SOCIETY.—The Chelmsford Engineering Society held its fourth annual conversazione on April 12th, and a very successful evening resulted. An excellent musical programme was arranged, and a number of interesting and instructive scientific demonstrations and exhibits were arranged, including the following:—Stroboscopic experiments; electrical toys; an analogy of an electrical circuit; electro-magnetic experiments by members of the staff of Crompton and Co., Limited; high speed ball bearings running up to 90,000 revolutions per minute, and sections of ball and roller bearings, &c., by the Hoffmann Manufacturing Company; broadcasting receivers; Geisler tubes; an otophone; aircraft wireless apparatus, and various chemical experiments, &c., by Messrs. Marconi's, and an X-ray demonstration by Newton and Wright, Limited, who exhibited their latest type of dental X-ray unit, comprising a high-tension oil-immersed transformer and self-rectifying Coolidge tube, the latter being mounted upon a counterbalanced tube stand, having provision for all necessary movements; a selection of X-ray tubes, including a "boiling water-cooled" pattern for producing the very hard radiations required in "deep" X-ray treatment, the penetration of which is automatically controlled; and a timing mechanism for accurately controlling exposures down to $^1/_{50}$ of a second, as required for rapid exposure of moving objects, such as the heart, as well as a selection of dental and other radiographs of general interest. In the absence of the President, Mr. A. A. Campbell Swinton through illness, Mr. J. H. Johnson presided. The Secretary's report on the year's working showed a good increase in membership, and a satisfactory financial result.

Provincial Letters.

THE MIDLANDS AND STAFFORDSHIRE.

(From our own Correspondent.)

General Situation.

COMPARATIVELY little iron or steel has been produced in the Midlands and Staffordshire this week, most of the works having taken a full week's holiday. Some firms have been glad of the respite to accumulate a few orders, while others have taken advantage of the opportunity to carry out necessary repairs. There were before the holiday stoppage sufficient raw materials in hand for the resumption of manufacturing activities; consequently the iron market at Birmingham to-day—Thursday—was but poorly attended. The business transacted did not amount to any great volume and was for the most part to cover immediate requirements. Prices remain unaltered from last week, but the tendency is to higher rather than lower values. Continental prices, though substantially less than those ruling in this country, are tending upwards, and offers of supplies are not now being "pushed." Belgian firms are stated to be well supplied with orders. In most departments there is not much inducement just now to make purchases outside the home market. Deliveries of foreign materials are delayed and manufacturers are having perforce to secure supplies to carry them on from local makers.

Steel.

In Midland steel works holidays have been general throughout the past week. Now business continues to come to hand, and though most of the orders are on the small side, they make a fair tonnage in the aggregate. A few more orders are being given out by the railways which are still very short of rolling stock, and unable to handle the traffic available. Complaints are very general of inability to get reasonably prompt delivery of coal, while the steel trade is further hampered through lack of wagons to dispose of the finished material. The trade continues to be comparatively free from foreign competition, though there are signs of German reappearance in the market. Some thin steel strip has been offered at prices well below the home quotation. Very little steel is now being offered by Belgium, and in some cases the quotations for finished material exceed the figures named by British steel works. The arrears of delivery have become serious, and very little reliance is now placed upon foreign supplies. The fact that prices have not materially improved under the relief from foreign competition indicates the keenness with which native works are seeking new business. Angles and joists continue to be quoted at £9 15s. to £10, and tees at £10 15s. Ship, bridge, and tank plates, ¾in. and over, are firm at £10 10s., and boiler plates at £14. Staffordshire hoops are quoted £12 at works, but some merchants claim to be able to secure supplies at half-a-crown below this figure. Semi-finished steel prices are firmer on the basis of £8 5s. for native billets, with a number of works claiming £8 10s. An occasional quotation from Belgium is received, the most recent naming £7 5s. per ton. Some surprise was expressed on 'Change to-day at the large output of steel registered for the month of March, establishing, as it did, a new record at 825,200 tons. For the busy period of 1920 the highest reached was 755,600 tons, and the comparison with the pre-war monthly average of 1913, which was 638,600 tons, gives a good idea of the growth of the steel business. Yet the proportion of unemployment in the steel trade is round about 16 per cent. This is accounted for, however, by the large expansion of capacity. Notwithstanding this large output, many works are only operating four days per week, but they are working continuously on triple eight-hour shifts. The chief complaint in the steel trade just now is the lack of profit. A large proportion of last quarter's output, it is contended by steel makers, has yielded no profit whatever.

Steel Scrap.

Steel scrap prices continue weak, though demand has improved pretty considerably of late. Large consignments continue to come in from the Continent at very low rates, and this keeps home quotations down. The severity of competition in this department is indicated by the importation of 121,055 tons of steel scrap from the three months ended March, as compared with 21,614 tons in the corresponding period last year.

Manufactured Iron.

The finished iron trade of the Black Country has, for the most part, been at a standstill during the week. Nearly all the works took a full week's holiday, partly on account of canal stoppages, rendered necessary by cleaning and repairing operations. The recent advance in prices of finished iron has not materially affected the current of business, and the marked bar houses which have good order books continue to find new business coming in to replace that just executed. They have no difficulty in securing £15 per ton for their product, though there is complaint of the general scale of iron prices, which are considered excessive, having regard to the keen competition of steel. Makers of merchant bar iron continue moderately employed, Staffordshire, Lancashire and South Yorkshire makers of Crown bars all quoting £13 per ton. It is possible, however, to buy at a lower figure in special cases. Nut and bolt and fencing iron is in but small request, and consumers only pay the £11 15s. or £12 demanded, when in immediate need of supplies. Makers say it does not pay them to accept business under these figures, and they would rather be without work than accept less. Very little Belgian nut and bolt iron is on offer and deliveries are very unsatisfactory. Users are managing for the most part to carry on, though occasionally they have to come on to the local market for small tonnages.

Sheet Values.

Galvanised sheets continue a somewhat weak market, the mills wanting new business. The general quotation for 24-gauge corrugated sheets is £17 10s., but business is being done at half-a-crown less, while even lower figures are mentioned in the case of good orders. The substantial character of the recent trade in galvanised sheets is shown by the export of 155,579 tons during the first quarter of the year, as against 154,741 in the same period last year.

Raw Iron.

Stocks of pig iron at Midland furnaces are not large. The policy of producers has been to adjust their output as closely as possible to current demand. With a better export inquiry for North Country pig iron the tone is strengthened. Production can be expanded as the need arises, but in the present relation of costs and selling prices and the uncertainty of the fuel position, smelters are anxious to consolidate such gains as have lately been made rather than seek to force the pace. The prices ruling this week are:—North Staffordshire forge, £4 7s. 6d. upwards; No. 3 foundry, £4 15s.; Northamptonshire forge, £4 5s.; foundry, £4 12s. 6d.; Derbyshire forge, £4 7s. 6d.; and foundry, £4 15s., all at furnaces. The pig iron production for March was, it is interesting to note, 668,600 tons, as compared with 612,700 the previous month, in spite of the reduction of eight in the number of operating furnaces. The March figures compare with 855,000 tons, the pre-war average, or about 200,000 tons over the present rate of manufacture.

Birmingham Brass Trade Wages.

A new wages agreement arrived at by the Joint Conciliation Board, representative of the Brassfounders' Employers' Association of the National Brass and Metal Mechanics' Society, has been finally approved. It provides for an advance of 1d. per hour to men of all grades. The agreed bonus will therefore be 21s. 6½d. per week of forty-seven hours. The bonus for youths between eighteen and twenty-one is to be increased by ½d. per hour, making their total bonus 11s. 4d. The new wage advance will take effect on the first pay day in May for work done in the previous week, and the arrangement will continue for six months definitely from April 17th. The new wage rates will be as follows:—C grade, £2 15s. 6½d.; D grade, £3 2s. 6½d.; D grade (polishers), £3 4s. 6½d.; E grade, £3 7s. 6½d.; E grade (polishers), £3 9s. 6½d. Youths' wages:—Eighteen years, £1 9s. 4d.; nineteen years, £1 14s. 4d.; twenty years, £1 19s. 4d. Day rates:—Fine casters, £4 1s. 6½d.; common casters, £3 15s. 6½d.; moulders, £3 3s. 6½d.; getters-down, £2 16s. 6½d.

Railway Contracts.

Midland rolling stock firms welcomed the new contracts given out by the London and North-Eastern Railway Company, amounting to £660,000, to the following firms:—Hurst, Nelson and Co., R. V. Pickering and Co., the Craven Railway Carriage and Wagon Company, Clayton Wagons, Midland Carriage and Wagon Company, and the Metropolitan Carriage, Wagon and Finance Company, for 290 coaches—twenty-nine trains of ten coaches each—for use on London suburban lines. The coaches, it is understood, will be of the new L. and N.E. design with teak bodies on steel underframes.

LANCASHIRE.

(From our own Correspondents.)

MANCHESTER.

General Conditions.

THE markets here are rather quiet after the holidays, and business is slow. Only a comparatively few people attended the Manchester Exchange meeting on Tuesday, and this is usually the most important meeting of the week. Possibly Friday may take its place this week, but it is unlikely that much business will be done on that day. As to the general outlook, there seems to be more hope in the cotton trade; and if that is going to revive, we may have larger inquiries for new machinery, and engineering business in this district will feel the benefit. The European situation also seems a little better than it was, and this improvement may assist trade during the second half of the year, although it comes too late to have much effect now.

Metals.

The movements in the copper market are not yet of a decisive character, although perhaps it is true that confidence in the future of copper prices is growing. The reduction in the United States stocks of copper at the end of March was much larger than had been generally anticipated; and, in fact, so large—23,000 tons—that some hesitation is expressed as to whether special circumstances have caused it. When the figures for the end of April are published we shall, of course, see whether such a rate of reduction is or is not exceptional; but if not, then the general statistical position of copper would very soon justify higher prices. The demand for copper from the American consumers does not seem to be very large now, but the European demand is much as usual. The point of interest is whether any large number of consumers will now arrive at the conclusion that it is time to build up stocks of metal in view of the needs of their trade during the remainder of the year. In the case of refined ingots there can be little risk in such a process beyond the loss of interest upon locked-up capital. There were sellers of best select ingot at £68 per ton recently, and of tough copper at £1 10s. to £2 per ton less, and one can scarcely imagine much risk of loss at these prices; but in the case of copper sheets, bottoms, tubes, &c., and of brass tubes, the question is different. The prices demanded for these manufactured forms of metal do not bear the normal relationship to ingot copper and spelter, and hence there is undoubtedly room for a fall even if standard and refined copper should remain as they are. Of course, one does not expect the normal pre-war relationship to be re-established until wages and general costs of manufacture

are again normal, but some reduction is certainly within the bounds of possibility, and possibly this impression leads to more "hand to mouth" buying than used to be the case. The market for tin has not yet settled down, although the movements have not been quite so violent as they were. So far as the statistics are concerned, the position does not appear much different from that of two months ago. If American buying should set in again it would have a startling effect on prices; but, of course, no one can tell when this buying may begin. All that can be said is that when prices drop below £250—as they have done recently—the moment seems favourable for consumers. In the lead market the downward movement seems to have been arrested for the present, and it seems possible that this went rather further than was altogether justified. There was, of course, little doubt that the highest prices reached were dangerous, and tended to check consumption; but a fall of about 25 per cent. was rather more than seemed called for. There has been some increase in production, which has helped to depress the market, but this is not of very great moment, and the consumption of lead is still very large. Spelter has been a steadier market of late, and as the price is now quite moderate, there does not seem to be any good reason to be afraid of this metal. Demand from the galvanisers is, however, still rather poor.

Pig Iron.

The market here for foundry iron is very quiet this week, but as no serious business was expected, there is no disappointment, and the quietness does not imply any weakness. Sellers of Derbyshire pig iron are quite firm at 95s. per ton at the furnaces, and the other Midland irons cost about an equivalent when delivered in Manchester. Buyers, however, are not quite so satisfied as they were as to the stability of the Cleveland prices, and some Cleveland iron has been offered in the North of Lancashire at less than the cost of Derbyshire iron. The fuel position is a little easier, but it is not expected that blast-furnaces in the Midlands will be able to buy coke at lower prices. As your readers know, the theoretical price of furnace coke is 24s., but it is not easy to buy at any less than 26s. per ton; and while this is the case, the present price of 95s. for No. 3 pig iron is moderate enough. The market for Scotch iron is said to be a little firmer here, and for most brands about 116s. 6d. per ton delivered is wanted; although it is still possible to buy at 115s. and perhaps at 114s. delivered. The better demand for Scotch—if the report be true—is supposed to indicate an improvement in the trade of the textile machinists.

Steel.

One cannot yet see any sign of returning life in the finished steel trade here. Business seems to be mainly confined to small lots, and prices are cut fine; so that the margin of profit is very small if it can be said that there is any margin at all. For joists and angles from £9 12s. 6d. to £9 15s. per ton is usually quoted, and for plates £10 to £10 5s. The stoppage in the shipyards naturally restricts business in plates, but it was almost as slack before this trouble began. The demand for manufactured iron seems poor, but probably it is as good as could be expected now that there is such a wide difference between iron and steel bars.

Scrap.

Dealers here in the scrap market are in a gloomy frame of mind, and find it very difficult to obtain orders sufficient to keep them clear of accumulations. For heavy steel melting scrap there is only a very weak demand, if one may call it a demand at all, when consumers seem quite indifferent to offers. The Lancashire dealer takes a risk if he pays more than about 70s. per ton on trucks. For heavy wrought scrap there is a quiet demand here at 97s. 6d. to 100s. per ton delivered to the forges. There is no business reported this week in cast scrap, but the prices are kept steady at from 87s. 6d. to 90s. per ton delivered at foundries in the district.

The Locomotive Building Industry.

Lancashire locomotive builders are very active in pursuit of business at the present time. Last week, as already reported, Beyer, Peacock and Co., Limited, obtained an order for a monster Garratt engine for the London and North-Eastern Railway. This engine is intended for hauling the mineral traffic, and it is hoped that it will prove the forerunner of further similar engines. Now I learn that the Vulcan Foundry, Limited, Newton-le-Willows, Lancashire, has been successful in securing an order for forty heavy passenger locomotives for the East Indian Railway. These engines will weigh about 120 tons each. They are to be of the 4–6–0 type and 5ft. 6in. gauge. This order has been obtained against world-wide competition, and the price has been cut down to the lowest possible in order to find employment for the Vulcan Company's workpeople.

Barrow-in-Furness.

Hematite.

The condition of the hematite iron market remains unaltered, and there is no sign of any more furnaces being put in blast at present. Some of the smelters hold stocks, and these will have to be cleared before there is any talk of increasing the output. There is a lack of life in the market, and it is expected that this state of things will continue for some time. The holidays have quietened things down a little, but there will be more to do when the labour troubles are at an end. Although the shipyard lock-out is at an end there is still the general demand for an increase to be put forward by the shipyard workers, and this is making many customers stick to small deliveries, just sufficient to take them along. Improvement in the trade with the Continent and America is likely, but it will come slowly. Regarding the former, much depends on the appreciation of the franc.

Iron Ore.

The iron ore trade is dull and is a reflection of the state of the iron trade. None of the mines are anything like approaching busy, and some are doing little or nothing. The Cumberland mines are bringing up most, and even that is not heavy. Business in foreign ores is dull, and there will not be any heavy importations until the iron trade revives.

Steel.

The steel trade is still quiet, and there are no immediate prospects of an improvement. The Barrow rail and merchant mills are still closed. The foundries are working and the hoop and section mills are active after a brief stoppage for the holidays. The Workington mills are not well fixed for orders.

Shipbuilding and Engineering.

The settlement of the Southampton trouble, which lead to a lock-out, is very welcome. The stoppage of men in Barrow did not hold any other work up, and the early return will allow construction to proceed all right. The Orient liner Orama, a new fast vessel for the Australian passenger trade, will be launched in May. A Donaldson liner and a steamer for the Anglo-Newfoundland Development Company to carry newsprint in reels to this country will follow in due course.

SHEFFIELD.

(From our own Correspondent.)

The Heavy Steel Trade.

The past week has not been a full one, owing to the Easter holidays, but the stoppage was not prolonged, most of the works having resumed operations by Thursday morning. The condition of the heavy steel trade shows little change. Large tonnages of basic and acid steel are being turned out, the latter variety being chiefly called for to supply the requirements of the shops producing railway material. There are complaints of the paucity of new orders for basic steel, but no furnaces have yet been shut down, and at the Templeborough Works ten out of the fourteen large furnaces are in operation, this being the largest number since the erection of the plant. The flow of new orders is expected to improve when existing contracts for foreign steel have been worked off, as, owing to the rise in prices, the Continent is not in a good position for carrying on competition to the same extent as in the past. The *Journal* of the Sheffield Chamber of Commerce points out that French and Belgian competition has been due almost exclusively to the depreciated currencies of those countries, which have stimulated exports, while home consumers have been starved. These conditions appear to be changing. The improvement in the value of the franc and the strong move in France for either taxation or prohibition of certain iron and steel exports are all in our favour.

The Outlook.

The same *Journal*, however, takes a gloomy view of the prospects, if present conditions continue. It states that in the near future some lines in the Sheffield heavy and medium trades may have to shut down. There are, it says, various reasons for this. Threats of labour troubles in the shipbuilding and engineering industries constitute one adverse factor, and the fear of dearer fuel is a check on some lines of business. At the same time, a sudden change in the situation is at least a possibility. If labour peace can be established at home an increased demand for ship steel and general engineering materials will almost immediately result, while better trade in railway equipment, colliery appliances, and builders' ironwork would soon follow. These considerations, coupled with the decline of foreign competition, afford grounds of hope for an improvement.

Railway Steel.

The extensive branch of the steel trade which turns out railway axles, tires, springs, and buffers continues to be well employed, and the numerous orders which the railway companies are still giving out will all bring trade to the city. At the same time, the comparative lack of overseas business in this department is disquieting. The returns for March revealed a considerable drop in the exports of railway material, thus showing that foreign buyers, who formerly sent much business to Sheffield, are going to the Continent for a good proportion of the axles and tires that they require. The large order placed last week by the London and North-Eastern Railway Company is even better for the Sheffield district than I mentioned in my last letter. The six firms among whom the contracts for about £660,000 worth of work have been divided include Craven's Railway Carriage and Wagon Company, Sheffield, as well as Clayton Wagons, Lincoln. The total amount of work comprised in the contracts is the building of 290 coaches (twenty-nine trains of ten coaches each) for the London suburban lines of the company. The coaches will be of the new L.N.E.R. design, with teak bodies on steel underframes. The trains will be built on the "articulated" principle, *i.e.*, they will each be composed of two sets of five vehicles, carried on six four-wheeled bogies, and will be fitted with steam heating and electric lights. The compartments will all have upholstered seats and backs.

A Steel Firm's Difficulties.

A sensation was caused in Sheffield last week by the issue of a circular stating that the debenture holders in Industrial Steels, Limited, had had to appoint a receiver. The company is an important one. It was formed at the beginning of 1922 to take over a part of the works of the old and successful firm of Jonas and Colver, Limited, this part including the Siemens-Martin steel furnaces, heavy mills and forges. The authorised capital is £700,000, of which £526,726 has been paid up. The company has had an unfortunate experience owing to the trade slump of the past two years, and in June last it was reported that there was a bank overdraft of £184,054 and a debit carried forward of £156,065. The shortage of available liquid resources has been a severe handicap to the company, and it is on this account that it finds itself unable to carry on its business pending other financial arrangements. It is at present well employed and has a healthy order book. The works are being carried on under the control of the receiver, and it is expected that a scheme of reconstruction will be placed before the creditors and shareholders within the next three weeks.

The Lighter Trades.

Little improvement can be recorded in the crucible steel trade. For the best high-speed steels and the various tools made from the material there is a very poor demand from those continental markets which have for years been so valuable to the trade. The engineering works at home are taking somewhat better supplies. There is a brisk inquiry for steel required for mining, quarry, masons', and heavy engineers' tools, both at home and in the Colonies. The condition of the cutlery and plate trades continues unsatisfactory. For cheap case goods a good sale is maintained, but prices are so low that old-established firms touch little of the business, the bulk of it going to small makers. In good-class cutlery and hollow-ware trade is slack, and the sales during the first quarter of this year were considerably below those of the corresponding period of last year.

Colliery Progress.

The sinking of the Thorne Colliery, near Doncaster, continues to progress satisfactorily. No. 1 shaft has now reached a depth of 770 yards, and it is expected that when a further 150 yards have been driven the Barnsley seam, 9ft. thick, will be reached. In the course of the operations recently a 2ft. seam of coal was struck, but it is not of commercial value. The continued expansion of coal enterprise in the Doncaster district is indicated by the fact that the Doncaster Collieries' Association has served notices upon the Rural District Council of its intention to work coal in the parishes of Marr, Brodsworth, Owston, Burghwallis, Edlington, Warmsworth, Wadworth, Hickleton, Hooton Pagnell, and Clayton-with-Frickley. A definite step towards the opening up of the coalfield in Lincolnshire has now been taken by the actual commencement of the boring at Doddington. It is believed that a continuation of the Barnsley seam will be found at a depth of about 900 yards. The boring is expected to occupy twelve or fifteen months and its cost will be £10,000. It is being carried out by a company with headquarters in Belgium, under the supervision of Mr. James Ford, of Doncaster. The extent of the property to be worked is 4716 acres.

Low Temperature Carbonisation.

A good deal of interest is being taken in Low Temperature Carbonisation, Limited, of whose activities extensive developments are foreshadowed. The company has for some years been established at Barugh, near Barnsley, and it is announced that it is about to embark on two new enterprises in the district. At Doncaster the company proposes to erect an installation consisting of 500 retorts. It is now in negotiation for a piece of ground on which to build its works, and has invited the Doncaster Corporation to take the surplus gas. The Corporation has not come to any decision at present. Negotiations are proceeding. The other centre which is mentioned in connection with the company's developments is Nottingham, where, it is understood, a plant containing no less than 1000 retorts is to be set up.

Canal and Bridge Work.

The Sheffield and South Yorkshire Navigation Company is proposing to carry out a rather extensive programme of repairs and renewals during the present year. The company has set aside a sum of £35,399 for deferred maintenance, very little of which has already been spent. The works now in contemplation will cost £19,804. They include the provision of a large dredger, £5234; lock renewals at Tinsley and Sprotborough, £4000; foundations and waterway wall for new warehouse at Doncaster, £3000; and several items of bridge rebuilding. A good deal of bridge work is being put in hand by the Derbyshire County Council. It has accepted a tender of £20,381 for the construction of a new bridge at Baslow, 250 yards lower down the river than the present structure. It is also going to put in hand the widening of Rowsley bridge. A tender of £2100 has been accepted for the widening of Lock Hill Bridge, Killamarsh, towards the cost of which the London and North-Eastern Railway Company has agreed to make a substantial grant, besides giving a portion of the land required.

Water and Sewerage Schemes.

The Doncaster Rural Council and the Tickhill Urban Council are proposing to form a joint authority for supplying water to certain colliery villages in the Doncaster area, particularly Rossington and Askern. At a Ministry of Health inquiry into the scheme, Mr. D. Balfour, C.E., of Newcastle and London, said the bore-hole at Austerfield was now 569ft. deep, and it was proposed to take a pumping test at 600ft. He estimated that the scheme, as already designed, would cost about £89,000. When completed, the Clifton reservoir would be able to supply the whole area. At Clay Cross, near Chesterfield, the Urban Council is seeking powers to borrow £20,000 for water supply works. It is proposed to construct a new reservoir on land adjoining the existing waterworks. The reservoir will have a capacity of 6,000,000 gallons and can easily be filled during the winter months, when water is running to waste. Greasborough Urban Council desires to borrow £6800 for sewerage and sewage disposal works. New outfall works are to be erected 500 yards east of the village, and 7ft. lower than the present works. More modern plant is to be put down and the Mangham sewage will be pumped to the new works.

NORTH OF ENGLAND.

(From our own Correspondent.)

Trade Recovery.

THERE is just now in trade circles in the North of England a general disposition to take a more cheerful view of the outlook. The movement towards trade recovery, it must be admitted, is slow; but it is healthy, and it justifies confidence in a continuous, steady improvement. The position in the pig iron trade is distinctly more hopeful, and some heavy contracts have recently been placed on foreign account. This is largely due to the fact that the price of Cleveland iron is now on a competitive basis with continental products. There has been no great expansion in the steel trade, but it is anticipated that the end of the lock-out in the shipyards will result in an improvement in business.

Cleveland Iron Trade.

Business in the Cleveland pig iron trade has been quiet this week in consequence of the holidays, but the undertone of hopefulness has continued. Confidence in the future is rather marked, mainly due to the fact that products of this district are comparatively cheap and such as prohibit the successful competition of continental makers in many markets, and an early renewal of activity is looked for. The easing of the price of Cleveland pig iron by half-a-crown per ton has had the effect of attracting further foreign business, and a substantial volume of fresh inquiries, many of which are likely to mature. Inquiries on German account are quite good, and negotiations are reported for sales to France, Belgium, and Scandinavia. It is noteworthy that in the first half of April as much pig iron was shipped from the Cleveland district as in the whole of February, and exports are likely to continue on the same heavy scale to the end of the month, as there are other big contracts to execute. There is also good reason to anticipate a marked improvement in the home trade, especially as Cleveland iron is the cheapest in the country. The price of No. 3 is firm at 92s. 6d. per ton, and an advance is by no means improbable. No. 1 foundry iron is perhaps not quite so scarce, and small lots are reported to be obtainable at 97s. 6d., whilst No. 4 foundry is 92s., and No. 4 forge 91s. 6d.

Hematite Pig Iron.

The position in the East Coast hematite pig iron trade shows little alteration. The demand is just about sufficient to absorb the current output, but the heavy stocks are not being liquidated. Nevertheless, some of the makers are not pressing sales at the net prices now ruling, being disposed to wait for a rise. However, mixed numbers of hematite are still easily obtainable at 99s. per ton, and No. 1 at 100s. In this branch also Germany is in the market to buy, and Italy is reported to be seeking supplies, whilst inquiries from other continental sources are circulating.

Ironmaking Materials.

The foreign ore trade is still in a depressed condition. High freight rates keep up the price, and low consumption further checks any inclination to make fresh contracts. Best Rubio ore might be bought at 23s. 6d. per ton c.i.f. Tees. Coke is in fair demand, and good medium furnace qualities can still be purchased at about 30s. per ton delivered at the works.

Manufactured Iron and Steel.

Many of the steel works in the North of England are closed down for the week, which is an indication of the state of their order books. Business rules on very quiet lines, but the end of the lock-out in the shipyards is expected to lead to an improvement. Billets are rather firmer, but no price changes are reported.

The Coal Trade.

There has been little real attempt to carry out business in the Northern coal trade this week owing to holiday influences. The home labour question does not appear to be so acute as recently, and advices from the Ruhr area point to work being continued on the late agreement. There is at the moment nothing to cause excitement in the export trade. The April position is quiet, as sellers have cleared all anticipated output, and buyers, although still holding orders, find little prospect of supplies or loading facilities. For next month there is only a small inquiry and no pressure from buyers. The tone of the market is nominally steady, but the tendency is for a further slight drop in values. The demand for foundry coke is dull and stocks are ample. Gas qualities are in moderate supply and steady.

SCOTLAND.

(From our own Correspondent.)

The Coal Trimmers' Dispute.

THE Scottish Dockers' secretary, Mr. Joe Houghton, who has been in London in connection with the coal trimmers' dispute, has just made a statement in regard to the Leith dockers' refusal to work on vessels loaded by volunteer trimmers. Mr. Houghton said that the employers' side of the National Conciliation Committee, dock and waterside, would this week discuss the legality or otherwise of the stoppage of work on vessels carrying general cargo having been blacklisted by the union. The question of the coal trimming dispute has been placed on the agenda for the Coal Trimming Joint Council meeting this week. Meanwhile the present policy of holding up blacklisted boats discharging general cargo or going to other ports for bunkers or coal would be carried on.

New Lothian Coal Pit.

On behalf of the Edinburgh Collieries Company, Limited, a new coal pit has been sunk at Elphinstone, East Lothian. The fuel in this area has been found to be of excellent quality, and there is a prospect of a very good output for many years to come.

The General Outlook.

Popular opinion seems to favour an early settlement of the labour troubles which at present are acting so adversely against the various markets. The latest movements in the coal trade on the wages question, and the developments in the shipyard trouble, seem to give reason to hope for an early settlement in each case. With this in view the outlook is certainly better, and it now remains for the hope to be justified. There is practically no doubt that orders are being held up pending a definite settlement of these disputes, and no doubt nothing will be left undone to effect a speedy and peaceful conclusion. The higher prices of continental material should reflect in favour of local producers, and, therefore, an early return to normal working conditions is all the more desirable.

Pig Iron.

Pig iron makers cannot report any expansion in business. Inquiries for foundry qualities are fairly numerous, but consumers are still loth to book anything beyond actual immediate requirements. At any rate, the output is quite equal to the demand. Prices are unchanged. Hematite is in much the same position so far as regards new business.

Finished Steel and Iron.

There is no improvement in the volume of business in steel and iron materials. Specifications for steel plates are particularly scarce, and sectional material is not much better off. Sheet mills, though not so busy as anticipated, are comparatively well occupied, and makers have enough work on hand to last some time ahead. The demand for galvanised sheets is not quite so good, and an easier tendency in prices is apparent. Official home quotations are unchanged. Bar iron makers are looking for new contracts and are not very successful. Orders on hand are running out, and few buyers are keen to pay on the present level of £12 10s. per ton for "Crown" bars for home delivery. The re-rolled steel branch of this industry is in a similar position, and only when very keen prices are quoted is business possible.

Coal.

Apart from the fact that a miners' strike seems more remote and the market somewhat easier in consequence, there is little, if any, change in the Scotch coal trade. The collieries in all districts are booked until the end of this month, and negotiations in the market are still chiefly confined to second-hand lots. So far as exports are concerned, good quantities of Lanarkshire fuel are going to continental destinations, and Ayrshire fuels to the Irish market. The Fifeshire collieries have strong demands for both round coal and washed nuts from the Baltic. Forward buying has been mentioned, but consumers are not inclined now to pay the current prices and lower quotations are expected. Aggregate shipments for the past week amounted to 280,456 tons, against 279,353 tons in the preceding week and 386,252 tons in the same week last year. The home pressure for fuel is not so insistent, but good deliveries are still taken.

WALES AND ADJOINING COUNTIES.

(From our own Correspondent.)

Coal Trade Outlook.

IT will be quite the end of this week or the early part of next before the conditions in the steam coal trade settle down, and it becomes possible to gauge accurately the position. Holidays at all times have an unsettling effect, but on this occasion there is the added influence of business having been driven away by the fears of a strike, and although these have almost completely been dispelled, it is not such an easy matter getting foreign buyers interested in supplies from this district, as they have made arrangements for coals from elsewhere. At the same time, there are Welsh coals, particularly of the superior class, which are always in favour with some consumers abroad, and for these the inquiry is coming in, though somewhat slowly, but the demand from the Continent is but a shadow of normal proportions. Very few hold any other opinion but that the coal trade in this district is in for a very quiet time during the next month or so, and prices will have to be cut to the finest limits to secure orders. Already coal prices have fallen 2s. 6d. to 3s. 6d. per ton as compared with a fortnight or so ago, and it is difficult to see how many owners will be able to avoid temporary stoppages at their pits during the next few weeks. A fair amount of tonnage was delayed over the holidays, but the quantity in dock is not sufficient to keep collieries busy for long. The holidays have, of course, made a difference to the supplies of coal available, but the general view is that with the exception of a few grades the standing stocks of coal will prove to be larger than is usual following a holiday period, and that there will be no difficulty in securing coals. The position is more likely to be that the collieries will require prompt tonnage to keep the pits going.

Pits to Close.

The fear has been expressed in colliery circles in this district that under the terms of the offer of the coal-owners for a settlement of the miners' demands, assuming that they are accepted, quite a number of colliery undertakings will have to consider their best methods of meeting the position, and this may involve the closing down of some of the most expensive parts of their property. One is reminded of this by the fact that three thousand miners employed by Guest, Keen and Nettlefolds, Limited, have received notices to terminate their contracts on the 30th inst. These men are engaged at the South Tunnel and Fochriw Nos. 1 and 2 collieries, and they represent more than half of the miners in the Dowlais district. Similar steps have been taken to dispense with the services of the officials employed at the pits in question, which means the total suspension of work at these collieries. Economic reasons are given as the cause of the employers' action, but it has caused a good deal of anxiety and alarm in the Dowlais district, and the workmen's agent has communicated with the Ministry of Mines with a view to securing an inquiry by that Department into the circumstances, as the miners' leaders hope to be able to prove at such an inquiry that there is no justification for the closing down of the pits affected. The whole of Fochriw's population, numbering about 2000, is dependent upon these two collieries for its livelihood, and if they are abandoned it will mean, according to the miners' agent, that Fochriw will become a derelict village.

Copper Works Combine.

The report is current in the Swansea district that two well-known Swansea copper works are about to be amalgamated. The firms mentioned are those of Messrs. Vivian and Sons and of Messrs. Williams, Foster and Co., which now embraces the works of Messrs. Pascoe, Grenfell and Sons. At the moment the report is not confirmed or denied. Both firms have large interests outside Swansea as well as inside. The firm of Messrs. Vivian and Sons is a private undertaking and was registered in 1914 to acquire the interests of the firm of Vivian and Sons, founded in 1810. The firm's works at Hafod, Swansea, were established in 1910. The authorised capital is £650,000, divided into A and B shares. The firm of Williams, Foster and Co. was registered in 1880, and four years later was amalgamated with Messrs. Pascoe, Grenfell and Sons. The firm owns the Morfa and Middle Bank Copper Works at Swansea and several other properties abroad. The authorised capital is £400,000.

Colliery Development.

The work of fixing the head gear and installing the surface plant at the new colliery undertaking of the Taff Merthyr Company, situated between Treharris and Trelewis, is now reaching the point of completion. The plant comprises the largest electrical winders in the British Isles. This new undertaking, involving approximately half a million capital, is the joint enterprise of the Powell Duffryn Steam Coal Company and the Ocean Coal Company, and it will be supplied with electric power both from the Ocean Company's power station at Treharris and from the power station of the Powell Duffryn Company at Bargoed, which is the largest of its kind in the world. The new colliery is designed to produce 3000 tons per day, and the work of sinking the new pits will be resumed at an early date.

Current Business.

The holidays have naturally interfered with business, and it is practically certain that it will be next week before the conditions are likely to be at all settled. The tone of the market is on the easy side, notwithstanding the curtailment of output by reason of the miners' holidays, which terminated on Tuesday night. There is a fair amount of coal standing, and in order to provide empty wagons to keep collieries working there is no doubt that colliery salesmen will be disposed to make concessions in price to those who can take immediate delivery. Best Admiralty large are nominally about 29s. to 30s., while superior smalls range about 20s. to 21s. If, however, collieries are unable to maintain regular working owing to shortage of orders, it is calculated that while large coals will weaken, the probability is that small coals will keep very steady, if indeed they do not improve.

CATALOGUES.

JIGS, Limited, 132, Long Acre, W.C. 2.—Catalogue on multiple-spindle drill heads.

HYATT, Limited, 56, Victoria-street, S.W. 1.—Pamphlet on the Hyatt mine tub wheel.

HARDY PATENT PICK COMPANY, Limited, Sheffield.—Mail card on "Hardy" compressors and "Hardy Simplex" air drills.

NATIONAL GAS ENGINE COMPANY, Limited, Ashton-under-Lyne.—Copy of pamphlet on National lighting sets.

SUFFOLK IRON FOUNDRY (1920), Limited, Stowmarket, England.—Pamphlet on acetylene welding of cast iron, welding rods and fluxes.

CHARLES LAIDLOW, 322 Petre-street, Sheffield.—A copy of Mr. Laidlow's speed and feed diary. Much useful information is embodied therein.

THE WESTON ENGINEERING AND DISPOSALS, Limited, 2A, Alexandra-road, Moss Side, Manchester, S.W.—Small map of Manchester and district.

ENGLISH ELECTRIC COMPANY, Limited, Queen's House, Kingsway, W.C. 2.—Copy of pamphlet on flameproof motors for mines. Its publication number is 322.

JOHN H. WILSON AND CO., Limited, Birkenhead, and 15, Victoria-street, S.W. 1.—Catalogue No. 60, lifting machinery, locomotive, steam and electric cranes.

GEORGE ELLISON, Perry Barr, Birmingham.—List No. 501 on hand-operated 6600-volt free handle oil breakers in steel-frame cubicles of the drop-down pattern.

JAMES KEITH AND BLACKMAN COMPANY, Limited, 27, Farringdon-avenue, E.C. 4.—Pamphlet K137 on K-B. timber drying system, also leaflet on lighting steamer fires by gas.

A. A. JONES AND SHIPMAN, Limited, East Park-road, Leicester.—A copy of the new season's catalogue of machine tools, which contains about 100 pages of closely condensed detail.

BABCOCK AND WILCOX, Limited, Babcock House, Farringdon-street, E.C. 4.—Catalogue No. 367 on silent gravity bucket and tray conveyors, automatic railways, &c. Catalogue of accessories. Section IV., high and low-pressure pipe work, &c. &c.

EDGAR ALLEN AND CO., Limited, Imperial Steel Works, Sheffield.—Copy of the "Edgar Allen Steel Book," which has been designed to provide a valuable reference book to the buyer. Price lists, lists of extras, hints on ordering, &c., are included.

Current Prices for Metals and Fuels.

IRON ORE.

N.W. Coast—	
Native	17/6 to 26/-
(1) Spanish	23/-
(1) N. African	23/-
N.E. Coast—	
Native	—
Foreign (c.i.f.)	24/-

PIG IRON.

	Home. £ s. d.	Export. £ s. d.
(2) **Scotland—**		
Hematite	5 2 6	—
No. 1 Foundry	5 5 0	—
No. 3 Foundry	5 0 0	—
N.E. Coast—		
Hematite Mixed Nos.	4 19 0	4 19 0
No. 1	5 0 0	5 0 0
Cleveland—		
No. 1	4 17 6	4 17 6
Silicious Iron	4 17 6	4 17 6
No. 3 G.M.B.	4 12 6	4 12 6
No. 4 Foundry	4 11 6	4 11 6
No. 4 Forge	4 10 6	4 10 6
Mottled	—	—
White	—	—
Midlands—		
(3) Staffs.—		
All-mine (Cold Blast)	9 2 6	—
North Staffs. Forge	4 7 6 to 4 10 0	
" " Foundry	4 15 0	—
(3) Northampton—		
Foundry No. 3	4 12 6	—
" Forge	4 5 0	—
(3) Derbyshire—		
No. 3 Foundry	4 15 0	—
Forge	4 7 6	—
(3) Lincolnshire—		
No. 3 Foundry	4 14 6	—
No. 4 Forge	4 13 0	—
Basic	4 11 0	—
(4) N.W. Coast—		
N. Lancs. and Cum.—		
Hematite Mixed Nos.	5 12 6 (a) / 5 17 6 (b)	—

MANUFACTURED IRON.

	Home. £ s. d.	Export. £ s. d.
Scotland—		
Crown Bars	12 10 0	—
Best "	—	—
N.E. Coast—		
Common Bars	12 10 0	—
Lancs.—		
Crown Bars	13 0 0	—
Second Quality Bars	12 0 0	—
Hoops	15 0 0	* 14 15 0
S. Yorks.—		
Crown Bars	13 0 0	—
Best "	13 10 0	—
Hoops	14 10 0	—
Midlands—		
Crown Bars	13 0 0	—
Marked Bars (Staffs.)	15 0 0	—
Nut and Bolt Bars	11 15 0 to 12 0 0	
Gas Tube Strip	13 5 0	—

STEEL.

	(6) Home. £ s. d.	(7) Export. £ s. d.
(5) **Scotland—**		
Boiler Plates	13 10 0	—
Ship Plates, ¼in. and up	10 5 0	—
Sections	10 0 0	—
Steel Sheets, 3/16in. to ¼in.	13 10 0	—
Sheets (Gal. Cor. 24 B.G.)	—	18 7 6

STEEL (*continued*).

	Home. £ s. d.	Export. £ s. d.
N.E. Coast—		
Ship Plates	10 5 0	—
Angles	10 0 0	—
Boiler Plates	13 10 0	—
Joists	10 0 0	—
Heavy Rails	9 0 0	—
Fish-plates	13 0 0	—
Channels	10 5 0	£9 to £9 5
Hard Billets	10 5 0	—
Soft Billets	9 0 0	—
N.W. Coast—		
Barrow—		
Heavy Rails	9 5 0†	—
Light "	9 10 0 to 10 0 0†	
Billets	8 10 0 to 12 0 0†	
Manchester—		
Bars (Round)	10 0 0 to 10 5 0	
" (others)	9 15 0 to 10 2 6	
Hoops (Best)	15 5 0	15 0 0
" (Soft Steel)	13 15 0	13 10 0
Plates	10 0 0 to 10 5 0	—
" (Lancs. Boiler)	13 10 0	—
Sheffield—		
Siemens Acid Billets	12 10 0	—
Bessemer Billets	13 0 0	—
Hard Basic	10 5 0	—
Intermediate Basic	10 0 0	—
Soft Basic	8 15 0	—
Hoops	12 10 0 to 13 0 0	
Soft Wire Rods	11 0 0 to 11 10 0	
Midlands—		
Small Rolled Bars	10 0 0 to 10 10 0	
Billets and Sheet-bars	8 5 0 to 8 10 0	
Sheets (20 W.G.)	11 10 0 to 12 0 0	
Galv. Sheets, f.o.b. L'pool	17 10 0	—
Angles	9 15 0 to 10 0 0	
Joists	9 15 0 to 10 0 0	
Tees	10 15 0 to 11 0 0	
Bridge and Tank Plates	10 10 0	—
Boiler Plates	14 0 0	—

NON-FERROUS METALS.

Swansea—	
Tin-plates, I.C., 20 by 14	24/3 to 24/6
Block Tin (cash)	243 10 0
" (three months)	243 5 0
Copper (cash)	64 5 0
" (three months)	65 2 6
Spanish Lead (cash)	31 10 0
" (three months)	29 15 0
Spelter (cash)	32 7 6
" (three months)	32 5 0
Manchester—	
Copper, Best Selected Ingots	69 0 0
" Electrolytic	70 10 0
" Strong Sheets	98 0 0
" Tubes (Basis price)	0 1 1½
Brass Tubes (Basis price)	0 1 0½
" Condenser	0 1 2½
Lead, English	34 10 0
" Foreign	33 0 0

FERRO ALLOYS.

(All prices now nominal.)

Tungsten Metal Powder	1/8½ per lb.	
Ferro Tungsten	1/4½ per lb.	
	Per Ton.	Per Unit.
Ferro Chrome, 4 p.c. to 6 p.c. carbon	£24 0 0	10/6
" 6 p.c. to 8 p.c. "	£23 10 0	8/-
" 8 p.c. to 10 p.c. "	£22 0 0	8/-
" Specially Refined		
" Max. 2 p.c. carbon	£42 10 0	16/-
" " 1 p.c. "	£51 0 0	17/6
" " 0.75 p.c. carbon	£75 0 0	20/-
" carbon free	1/5 per lb.	
Metallic Chromium	4/3 per lb.	
Ferro Manganese (per ton)	£17 for home, £17 for export	
" Silicon, 45 p.c. to 50 p.c.	£11 10 0 scale 5/- per unit	
" " 75 p.c.	£18 0 0 scale 6/- per unit	
" Vanadium	19/9 per lb.	
" Molybdenum	8/6 per lb.	
" Titanium (carbon free)	1/3 per lb.	
Nickel (per ton)	£135	
Cobalt	10/6 per lb.	
Aluminium (per ton)	£82 to £100 (British Official.)	

FUELS.

SCOTLAND.

	Export.
Lanarkshire—	
(f.o.b. Glasgow)—Steam	24/-
" " Ell	26/-
" " Splint	25/6 to 27/6
" " Trebles	25/9
" " Doubles	25/-
" " Singles	22/-
Ayrshire—	
(f.o.b. Ports)—Steam	24/-
" " Splint	25/6
" " Trebles	25.9
Fifeshire—	
(f.o.b. Methil or Burntisland)—Steam	23/- to 25/6
Screened Navigation	32/-
Trebles	25/6
Doubles	24/3
Singles	21/-
Lothians—	
(f.o.b. Leith)—Best Steam	24/6
Secondary Steam	23/6
Trebles	25/6
Doubles	24/3
Singles	21/6

ENGLAND.

(8) **N.W. Coast—**	
Steams	32/-
Household	49/- to 59/-
Coke	38/6
Northumberland—	
Best Steams	25/6
Second Steams	24/6
Steam Smalls	16/-
Unscreened	23/- to 24/-
Household	26/- to 28/-
Durham—	
Best Gas	28/6
Second	23/- to 24/-
Household	26/- to 28/-
Foundry Coke	30/- to 32/6

Sheffield—	Inland.
Best Hand-picked Branch	36/- to 39/-
Barnsley Best Silkstone	34/- to 36/-
Derbyshire Best Brights	31/- to 35/-
" " House	27/- to 29/-
" " Large Nuts	27/- to 28/-
" " Small "	20/6 to 23/-
Yorkshire Hards	27/- to 30/-
Derbyshire "	25/- to 28/-
Rough Slacks	12/6 to 15/6
Nutty "	12/- to 14/-
Smalls	8/- to 10/-
Blast-furnace Coke (Inland) *	
" (Export) f.o.b.	31/6

(9) SOUTH WALES.

Cardiff—	
Steam Coals:	
Best Smokeless Large	29/- to 30/-
Second "	28/- to 29/-
Best Dry Large	27/6 to 28/6
Ordinary Dry Large	26/6 to 27/6
Best Black Vein Large	28/6 to 29/6
Western Valley "	28/- to 29/-
Best Eastern Valley Large	28/- to 29/-
Ordinary " "	26/6 to 27/6
Best Steam Smalls	20/- to 21/-
Ordinary "	18/- to 20/-
Washed Nuts	28/- to 30/-
No. 3 Rhondda Large	29/- to 30/-
" " Smalls	23/6 to 25/6
No. 2 " Large	25/- to 26/-
" " Through	21/- to 23/-
" " Smalls	18/- to 19/-
Coke (export)	55/- to 60/-
Patent Fuel	29/- to 32/-
Pitwood (ex ship)	27/- to 28/-
Swansea—	
Anthracite Coals:	
Best Big Vein Large	42/6 to 45/-
Seconds	40/- to 42/6
Red Vein	32/6 to 35/-
Machine-made Cobbles	50/- to 52/6
Nuts	45/- to 52/6
Beans	47/6 to 50/-
Peas	29/- to 30/-
Breaker Duff	13/- to 13/3
Rubbly Culm	16/6 to 17/-
Steam Coals:	
Large	24/6 to 26/6
Seconds	22/- to 24/-
Smalls	15/- to 18/-
Cargo Through	19/- to 22/-

(1) Delivered. (2) Net Makers' works. (3) f.o.t. Makers' works, approximate. (4) Delivered Sheffield. (5) Glasgow, Lanarkshire and Ayrshire.

(6) Home Prices—All delivered Glasgow Station. Boiler Plates 10/- extra delivered England. (7) Export Prices—f.o.b. Glasgow.

(8) Except where otherwise indicated, coals are per ton at pit for inland and f.o.b. for export, and coke is per ton on rail at ovens and f.o.b. for export. (9) Per ton f.o.b.

* Blast-furnace Coke (Inland): Special Price for Ironworks 24/-, open market 29/-. † Latest quotations available. (*a*) Delivered Sheffield or Glasgow. (*b*) Delivered Birmingham.

French Engineering Notes.

(From our Correspondent in Paris.)

Labour.

One of the most difficult problems confronting manufacturers is the inadequate supply of skilled labour which, in the engineering trades, is so scarce that some of the firms employing large numbers of men are obliged to resort to continuous advertising to keep the hands up to their full strength. The real reason for this state of things is to be found in the remarkable development of the engineering industries since the war. There has, consequently, been an increasing demand for skilled labour at a time when the supply has diminished through the suppression of the apprenticeship system, and the schools which aim at replacing apprenticeship in the shops do not turn out sufficient young men to meet requirements. The lack of good mechanics is also partly due to the methods adopted by some of the big firms which specialise their manufacture by keeping each man perpetually on one job, and as the men are paid at rates fixed by experts working on those particular jobs they are usually able to earn good wages with a good output. Such men are not skilled in the proper sense of the term. They are usually labourers who become skilled in one operation by constant repetition, and thus there has arisen a class of "specialised labourers" whose influence is undoubtedly detrimental to the development of skilled labour. A young man does not see the necessity of going through the apprenticeship offered by a technical school when he can start right away by earning good wages on a specialised job. These men earn as much as, and often more than, a skilled hand, and being "specialised labourers" they claim a higher standard of wages even when seeking work for which they are not specially qualified. This standard is affecting the wages of labourers generally, and is tending to increase still further the wages of skilled hands who consider that the margin is not sufficiently in their favour. So deficient is the supply of skilled hands that every encouragement is being offered for the immigration of foreign workmen who are coming from Hungary, Poland, Czecho-Slovakia, Italy and Spain, and in many works the proportion of foreign workmen is very high.

Colonial Works.

A sum of 40 million francs is to be spent upon an extension of the railway system in the Cameroons under the French mandate as well as upon improvement works to the port of Douala. On the outbreak of the war the Germans were only working 174 kiloms. of line, and during the hostilities this section was badly damaged and the greater part of the rolling stock destroyed. Since the French State took over the lines four years ago, the damage has been repaired and the programme of extension is to be carried out immediately with funds voted by the home Government, together with a smaller sum which is to be raised by the mandated territory itself. As the old capital of the Cameroons is in the British part of the territory, a new capital has been created at Yaoundé, and the line is to be extended to that centre, a distance of 133 kiloms. It will be continued eventually to the hinterland, where the opening up of the country is expected to provide considerable traffic to Douala, and in view of that traffic new wharves are to be constructed and the port dredged. A sum of 60 million francs is also to be devoted to an extension of the port of Oran in Algeria, where the traffic has increased out of all proportion to the facilities offered by the port. It is intended to construct a new harbour and to carry out various other works to cope with the steadily increasing tonnage.

The Batignolles Tunnels.

The old Batignolles tunnels approaching the Gare St. Lazare in Paris have been demolished except for a length of about 75 m., where a particularly interesting work is being carried out under the Boulevard des Batignolles. At this point the tunnels carry the Metropolitan and the gas, water, compressed air and electric mains, and the whole of these have to remain undisturbed during the construction of a large girder bridge preparatory to the removal of what still remains of the tunnels. The first operation is to build the section of the bridge which is to take the Metropolitan. Girders were first laid under the tracks, and now the tunnel is being removed to allow the bottom girders supporting the tracks to be built into a lattice bridge. This bridge will then be widened each side to support the boulevard. It is expected that the Metropolitan bridge will be completed in about three months' time, and the whole of the undertaking will be finished a year later, when all that now remains of the old Batignolles tunnels will have entirely disappeared.

Competition.

The stabilisation of the franc during the past two weeks has had a steadying effect upon the situation generally, but it has not brought about any improvement, for the reason principally that producers are finding it more and more difficult to secure foreign business, and are therefore offering better terms to home consumers, who refuse to place forward orders when they see a prospect of getting lower prices later on. Not only has the foreign demand fallen away with the improvement in the franc, but it is feared that some of the accumulating stocks of iron and steel in other countries will find their way here, especially if the exchange rate should further improve. English mill owners are offering to deliver ship plates in the West of France at a lower price than the Lorraine rolling mills can quote at works. In view of the change that has come over the situation particular interest is being taken in the future supplies of coke. The agreement with the German coke oven owners has been extended for another two months and consignments have been satisfactory; but there is no change in prices, nor is there likely to be until a permanent agreement ensures sufficient supplies to meet all requirements. The only encouraging factor in trade at the moment is the reported suppression of the 33 per cent. import duty on certain goods entering Great Britain, which is particularly gratifying to the motor car firms.

British Patent Specifications.

When an invention is communicated from abroad the name and address of the communicator are printed in italics.

When an abridgment is not illustrated the Specification is without drawings.

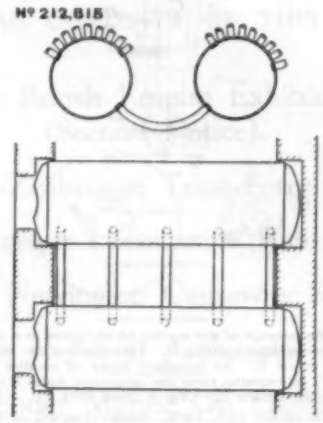
Copies of Specifications may be obtained at the Patent Office Sale Branch, 25, Southampton-buildings, Chancery-lane, W.C., at 1s. each.

The date first given is the date of application; the second date, at the end of the abridgment, is the date of the acceptance of the complete Specification.

STEAM GENERATORS.

212,815. July 10th, 1923.—Water-tube Boilers, The Stirling Boiler Company, Limited, 54, Victoria-street, Westminster, and H. J. S. Mackay, Rosemount, Bellevue-road, Ryde, Isle of Wight.

This invention relates to five-drum Stirling and other boilers having two lower or mud drums, and has for its object an

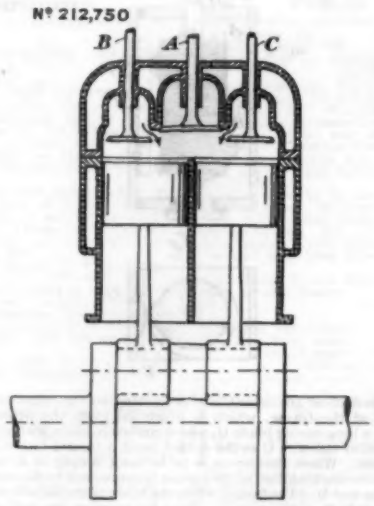


improved arrangement by which the equilibrium between the two lower or mud drums is maintained. The lower halves only of the lower or mud drums are connected, and preferably such connection is afforded by a series of curved tubes uniformly spaced lengthwise of the drums, as shown in the illustration.—*March 20th*, 1924.

INTERNAL COMBUSTION ENGINES.

212,750. March 23rd, 1923.—Inlet Valves, P. St. George Kirke, Parliament Mansions, Victoria-street, London, S.W.1.

The object of this invention is to permit combustible charges, small by comparison with the capacity of the engine, to be exploded with certainty. The engine has two cylinders, as

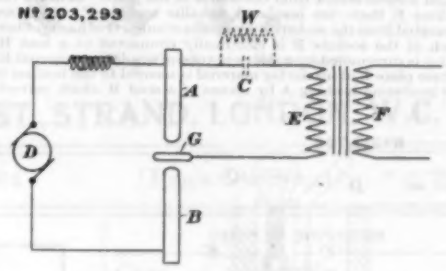


shown, one exhaust valve A, a gas inlet valve B, and an air inlet valve C. The explosive mixture and the air or non-explosive mixture are drawn in separately and do not mix appreciably during either the admission or compression strokes, so that the charge is not diluted below the point at which it will ignite readily.—*March 20th*, 1924.

TELEGRAPHS AND TELEPHONES.

203,294. March 13th, 1923.—Improvements in Telephone Transmitters and Receivers, Gesellschaft für Drahtlose Telegraphie, m.b.H., of 9, Tempelhofer Ufer, Berlin, S.W. 11, Germany.

This invention relates to telephonic transmitters and receivers in which an electric arc is employed. In the accompanying diagram A B are the electrodes between which the arc is produced by a generator D. Between the electrodes A B is a ring G which is connected through one winding E of a transformer to the electrode A, and which reduces the volume of the arc and renders the arc less stable. When the arc is employed as a transmitter and sound waves fall upon it, the resistance of the arc between the control electrode G and the electrode A varies, and in consequence there exists in the winding E an alternating voltage which corresponds to the sound waves. Consequently currents which may be employed to actuate a telephone receiver will appear in the winding F of the transformer. When the arc is employed as a receiver currents due to speech produce between the control electrode G and the electrode A an alternating voltage which will affect the conductivity of the arc, and the arc will consequently reproduce the speech. In some cases it is found advantageous to insert between the winding E and the electrode A a condenser C shunted by a resistance W. Preferably means are provided for cooling the control electrode. The pro-

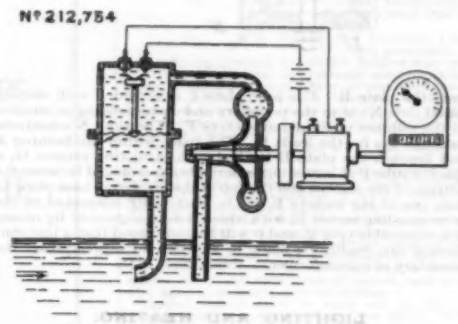


vision of the control electrode makes the arc more sensitive and enables it to be worked as a receiver with smaller controlling current than would otherwise be the case.—*March 13th*, 1924.

MEASURING AND TESTING INSTRUMENTS.

212,754. March 26th, 1923.—Pitot Tube Flow Meters, L. A. Diyaneff, 3425, Giles-place, New York.

The Pitot tube, when directly connected to a flow meter, will register dynamic pressures, but the scale is usually graduated in units of velocity. The pressure, however, being proportional to the square of the velocity, the scale divisions must be of ever increasing length, so that the apparatus becomes impracticable for any wide range of velocities. The inventor, however, does not use the Pitot tube directly on an indicating element, but pro-

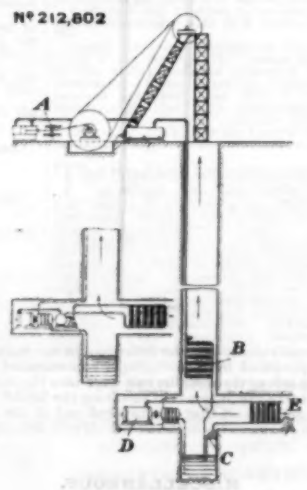


duces artificially an equivalent pressure by means of a pump or blower in order to balance the pressure in the Pitot tube. An ordinary speedometer registers the rotational velocity of the pump motor. The pressure developed by a pump or blower is directly proportional to the square of the velocity or to the square of the number of revolutions per minute of the rotor or impeller, and the pressure in the Pitot tube being proportional to the square of the fluid velocity, it follows that with this arrangement the number of revolutions of the pump impeller is directly proportional to the velocity of the moving fluid.—*March 20th*, 1924.

MINING MACHINERY.

212,802. June 18th, 1923.—Ventilating Mines, F. Heise, Hernerstrasse 43, Bochum, Germany.

The inventor proposes to ventilate mines by heating the upcast shaft with exhaust steam. The exhaust from a surface engine, such as A, is led down the shaft and is condensed in a radiator B,



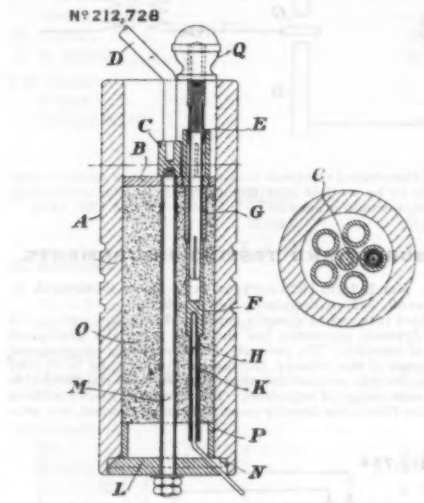
the condensate being discharged into the sump C. The steam used in a turbine-driven drainage pump D can also be used to heat the air by means of an atmospheric condenser E. The specification includes calculations to show the probable efficiency of the system.—*March 20th*, 1924.

TRANSFORMERS AND CONVERTERS.

212,728. February 22nd, 1923.—Improvements relating to Terminals for Electric Transformers, John Bentley Hansell, of 121, Eccles Old-road, Manchester; Benedict Beesley, of 100, Newport-road, Chorlton-cum-Hardy, Manchester; and the Metropolitan-Vickers Electrical Company, 4, Central-buildings, Westminster.

This invention relates to terminals for transformers, and the object is to provide an improved terminal of this kind for enabling a line connection to be easily made to any desired tapping from the secondary winding. The terminal shown comprises a tube or bushing A constructed of porcelain and a transverse metal plate or partition B, which is provided

with a central connecting member or terminal C for the reception of a line connection D consisting, for example, of a flexible cable. A number of sockets E are mounted upon the plate B and project upwards. The sockets are equidistantly spaced round a circle struck from the centre of the plate. Beneath the sockets E there are insulated metallic sockets F, which are separated from the sockets E by means of tubes G of hard rubber. Each of the sockets F is electrically connected to a lead H, which is surrounded by a sleeve or tube of insulating material K. A base plate L of insulating material is secured to the bottom of the insulating bushing A by means of a stud M which extends



from the plate B. The base plate L is provided with sloping radial slots N cut in the periphery and corresponding in number to the number of insulated sockets F. The slots N constitute passageways for the leads H. The space within the bushing A and beneath the plate B is filled with insulating cement O, a spacing tube P of insulating material being arranged between the bottom of the cement and the top of the insulating base plate L. Any one of the sockets F can be electrically connected to the corresponding socket E, with which it is in alignment by means of a removable plug Q, and it will be understood that a line connection can readily be made to any desired tapping from the secondary of a transformer.—*March* 20*th*, 1924.

LIGHTING AND HEATING.

201,537. June 29th, 1923.—Improvements in and relating to Arc Lamp Carbons and Electrodes, Paul Schiff and Co., of Schiocchat, near Vienna, and Dr. August, of the same address.

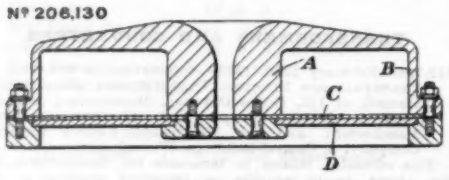
This invention relates to an arc lamp carbon provided with a metallic covering A which is thicker at the combustion end than it is at the other end. The metallic coating is deposited on the

carbon electrolytically and the difference in the thickness of the coating is produced by introducing a concentrated solution of the metallic salt or the metallic salt itself into the bottom of the bath, care being taken to avoid agitating the liquid. It will, of course, be understood that the tapered end of the carbon rod shown points downwards in the bath.—*March* 20*th*, 1924.

MISCELLANEOUS.

206,130. October 24th, 1922.—Improvements in Lifting Magnets, Fried Krupp Aktiengesellschaft, of Essen, Germany.

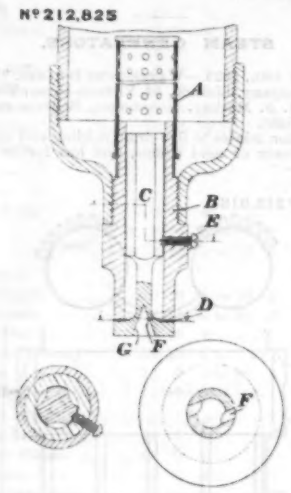
The object of this invention is to provide a lifting magnet in



which the coil is enclosed in a water-tight space in a simple and cheap manner. In the drawing, A and B are the poles. The space between the poles and which receives the coil is closed by a plate C composed of dynamo steel and also a protective plate D, consisting of chromium steel. The manner in which these plates are secured will be obvious from the drawing. The main advantage claimed for the invention is that a perfectly water-tight enclosure is obtained without having to carry out accurate work on the protective plate, which is composed of very hard steel and which is not permeable to magnetic lines of force.—*March* 20*th*, 1924.

212,825. August 16th, 1923.—Water Sprays, Babcock and Wilcox, Limited, Farringdon-street, London, E.C. 4, and S. F. Weston, 65, Schubert-road, East Putney, London, S.W.

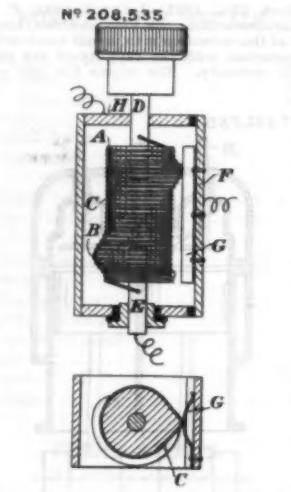
This spray, which is fitted to its supply pipe by means of a reducing socket, and is provided with a gauze strainer A comprises a body B and a plug C. The plug is grooved longitudinally



to permit the passage of the water, which issues as a thin sheet from the fine annular opening D. This opening can be adjusted by the set screw E. An auxiliary spray of smaller radius is produced by jets issuing from the tangential holes F impinging on the conical surface G.—*March* 20*th*, 1924.

208,535. December 11th, 1923.—Improvements in Variable Resistances, Société Belge Radio-electrique Société Anonyme, of 23, Boulevard de Waterloo, Brussels, Belgium.

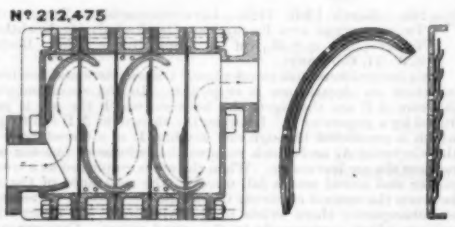
This invention relates to variable resistances, and its object is to provide a resistance of that type which shall be simple, cheap, and durable. A is a former of insulating material, which has a helicoidal lump or projection B formed upon it. A helicoidal groove of much smaller pitch than that of the lump is cut on the surface of the former and in this groove a resistance wire C is wound. The former is mounted on two spindles D and E, which are supported in the ends of a rectangular frame. The spindle D is provided with a milled head, by which the former can be turned,



and the ends of the wire C are connected to the spindles. The side F of the frame, which is insulated from the other part, carries a long spring blade G, which makes contact with different portions of the wire C as the milled head is turned into different positions. When the device is to be used simply as a variable resistance one terminal of the circuit is connected to the spindle E or to the end H of the frame, while the other terminal is connected to the side F of the frame. Thus by turning the milled head varying lengths of resistance wire can be put into circuit. When the device is to be used as a potentiometer the supply circuit is connected to the spindle E and the end H, while the circuit to be supplied is connected to the side F and either the end H or the spindle E.—*March* 13*th*, 1924.

212,475. June 26th, 1923.—Oil Separators, Rokuro Sumiyama, No. 33, Gochome Imabashi, Higashi-ku, Osaka, Japan.

This separator comprises a series of chambers with communicating openings. In each chamber there is a guide plate of gradually decreasing radius of curvature, which lends the steam



into the next compartment. The guide plates are furnished with bent strips, as shown in the detail view, which form channels for trapping oil in the steam. The oil escapes through holes in the back of the guides into recesses behind, and is drained away. —*March* 13*th*, 1924.

Forthcoming Engagements.

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of its insertion, the necessary information should reach this office on, or before, the morning of the Wednesday of the week preceding the meetings. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

TO-DAY.

Institution of Engineering Inspection.—Royal Society of Arts, John-street, Adelphi, London, W.C. 2. Paper, "Radiology in Inspection," by Mr. V. E. Pullin. 8 p.m.

Institution of Mechanical Engineers.—Graduates' visit to Messrs. J. Lyons and Co., Cadby Hall, Kensington, London, W. 1. 5.45 p.m.

Junior Institution of Engineers.—39, Victoria-street, London, S.W. 1. Lecturette, "Aluminium Electrical Conductors for Overhead Power Transmission," by Mr. H. G. Williams. 7.30 p.m.

Radio Society of Great Britain.—Institution of Electrical Engineers, Savoy-place, Victoria Embankment, London, W.C. 2. Informal meeting of Transmitter and Relay Section. Discussion on "Short Wave Transmitters," opened by Mr. Simmonds. 6.30 p.m.

SATURDAY, APRIL 26TH.

Institution of Automobile Engineers.—London graduates visit to the Lee Bridge pumping station of the Metropolitan Water Board. 2.30 p.m.

Institution of Civil Engineers.—Students' visit to the activated sludge sewage disposal works at Reading.

North of England Institute of Mining and Mechanical Engineers.—Newcastle-upon-Tyne. General meeting. 2 p.m.

MONDAY, APRIL 28TH.

Faraday Society and the Institute of Metals, with the Co-operation of the British Non-ferrous Metals Research Association and the Institute of British Foundrymen.—Institution of Mechanical Engineers, Storey's-gate, Westminster, S.W. 1. General discussion on "Fluxes and Slags in Metal Melting and Working." 3 p.m.

Illuminating Engineering Society.—Royal Society of Arts, John-street, Adelphi, London, W.C. 2. Discussion on "Some Problems in the Lighting of Textile Mills," to be opened by Messrs. E. L. Oughton and P. J. Waldram. 8 p.m.

Institution of Automobile Engineers: Scottish Centre.—Royal Technical College, Glasgow. Paper, "Light Alloys for Pistons and Connecting-rods," by Dr. L. Aitchison. 7.30 p.m.

TUESDAY, APRIL 29TH.

Institution of Automobile Engineers.—Royal Society of Arts, John-street, Adelphi, London, W.C. 2. Informal meeting. Discussion on "Coil *versus* Magneto Ignition." 6 p.m.

Institution of Civil Engineers.—Great George-street, London, S.W. 1. Further discussion on "The Barton Power Station of the Manchester Corporation and the Transmission System in Connection therewith," by Messrs. H. N. Allott and S. L. Pearce: "Dalmarnock Electricity Works," by Mr. W. Burnside. 6 p.m.

Institution of Electrical Engineers: North Midland Students' Section.—The University, Leeds. Annual general meeting. 7 p.m.

WEDNESDAY, APRIL 30TH.

Engineering Golfing Society.—On the course of the Beaconsfield Golf Club. Spring meeting. 10 a.m.

Institution of Automobile Engineers: North of England Centre.—Milton Hall, 244, Deansgate, Manchester. Paper: "Light Alloys for Pistons and Connecting-rods," by Dr. L. Aitchison. 6.30 p.m.

Institution of Civil Engineers.—Great George-street, London, S.W. 1. Annual general meeting of the Association of London Students. 6 p.m.

Liverpool Engineering Society.—9, The Temple, Dale-street, Liverpool. Annual general meeting. 8 p.m.

Radio Society of Great Britain.—Institution of Electrica Engineers, Savoy-place, Victoria Embankment, London. Lecture by Captain P. P. Eckersley on "Faithful Reproduction by Broadcast." (Note.—This meeting was originally arranged to be held on April 23rd.) 6 p.m.

THURSDAY, MAY 1ST.

Royal Institution of Great Britain.—21, Albemarle-street, Piccadilly, London, W. 1. Annual meeting. 5 p.m.

FRIDAY, MAY 2ND.

Chemical Engineering Group.—The Watt Room of the Engineers' Club, 39, Coventry-street, London, W. 1. Annual general meeting. 6.30. After the meeting there will be an infomal dinner, followed by a social evening.

Junior Institution of Engineers.—39, Victoria-street, London, S.W. 1. Lecturette, "Electric Lighting in Churches," by Mr. F. H. Taylor. 7.30 p.m.

Royal Institution of Great Britain.—21, Albemarle-street, Piccadilly, London, W. 1. Discourse on "Petra," by Sir Alexander Kennedy. 9 p.m.

MONDAY, MAY 5TH.

Royal Institution of Great Britain.—21, Albemarle-street, Piccadilly, London, W. 1. General meeting. 5 p.m.

Society of Engineers.—Geological Society's Rooms, Burlington House, Piccadilly, London, W. 1. Paper, "Some Factors of Sea Defence Work," by Mr. C. H. J. Clayton. 5.30 p.m.

WEDNESDAY, MAY 7TH.

Institution of Electrical Engineers.—Savoy-place, Victoria Embankment, London, W.C. 2. Wireless Section meeting. "Faithful Reproduction in Radio Telephony," by Mr. L. C. Pocock. 6 p.m.

THURSDAY, MAY 8TH.

Iron and Steel Institute.—Hotel Cecil, Strand, London, W.C. 2. Annual dinner. 7 for 7.30 p.m.

THURSDAY AND FRIDAY, MAY 8TH AND 9TH.

Iron and Steel Institute.—Institution of Civil Engineers, Great George-street, London, S.W. 1. Annual meetings. For programme see page 395. 10.30 a.m. each day.